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Rohlwing Road (State Route 53) over Golf Road (State Route 58)
This graceful structure, recently completed and not yet opened to traffic, anticipates a future widening of Route 58, an important east and west thoroughfare. Side ramps connect the two roads.
—(Photo April 20, 1935)

SOME RECENT SEPARATIONS OF HIGHWAY GRADES IN COOK COUNTY, ILLINOIS

VARIOUS types of railway and highway grade separations recently constructed in and near Chicago were illustrated in the May issue of ROADS AND STREETS, and their costs reported briefly. Herewith is a companion set of pictures and cost data on the highway grade separations made during the past four years. Many other interesting cases might have been added without going beyond the limits of Cook County, but available space does not permit showing them here. Future issues of this magazine will contain pictures and costs of such structures, not only in Cook County and the State of Illinois, but at widely scattered points throughout the country.

A systematic program of highway grade separation in the Chicago district was begun several years ago when congestion at important highway intersections because intolerable. This program was extended rapidly, and many crossings not originally considered as needing separation have now been made both safe and convenient. Only people who have used the roads under both old and new conditions can appreciate the relief thus afforded. The change is doubly impressive when considered in connection with the increase in motor traffic.

Plans are now being made for other important separations. When these are completed others undoubtedly will follow, and residents of the Chicago metropolitan area can look forward to a steady improvement of conditions.

While there has been a natural tendency toward standardization on types which have proved desirable, there is also discernible a steady improvement in the design of these structures. The future probably will witness an increase in variety, with each structure more closely adapted to the particular conditions of its location. This will include architectural as well as engineering consideration.

Most of the highway separations here shown were constructed by the State of Illinois: the remainder were built by the County of Cook, and are so designated. The price per cubic yard of concrete is given exclusive of cement, the cement in all cases being shown as an independent item. Overhead costs are not included except in one or two instances where a minor item of engineering is shown.

In the level country in which most of these grade separations are located drainage of subways is frequently a difficult problem. For example, at Cumberland station, gravity drainage is possible, although a 775 foot run of pipe is necessary to effect it; while at Mannheim Road and North Avenue the subway drainage must be pumped a distance of 3,000 feet to Addison Creek. The automatic motors and pumps of these installations are not the least interesting features of the grade separations.

On the theory that a beautiful structure is worthy of beautiful surroundings, extensive landscape work is being carried out at many of these locations. The treatment consists in the sodding of embankments, the planting of trees and shrubs, and in some cases, of artistic rock work. A large part of it is being done by CCC forces.

OGDEN AVENUE, LA GRANGE (U. S. ROUTE 34), OVER LOCAL STREETS AND INDIANA HARBOR BELT RAILROAD TRACKS

Upper View: Westerly End of the Viaduct as Seen from Burlington St.
Lower View: The Viaduct Extends in a Sweeping Curve over Streets and Tracks.

One of Two Stairways Connecting Viaduct and Street below.
Height 24 ft. 8 in.; Columns 15 x 15 in.; Column Footings 36 x 36 in., 24 in. thick.

Structure

Plate girder viaduct of 12 unequal spans on concrete piers. Approaches on earth fills between concrete retaining walls. The main line of the viaduct is curved. The approaches are on curves reversed to each other, and extending onto viaduct. Stairways are provided at two points, connecting the viaduct and lower street levels.

Length of viaduct between abutments	774.19 *ft.*
Length of west approach	236.00 *ft.*
Length of east approach	312.50 *ft.*
Total Length Viaduct and Approaches	1,322.69 *ft.*
Width of roadway	44 *ft.*
Width of sidewalk	5 *ft.*
Total Width	49 *ft.*

Completed April, 1932.

Cost of Viaduct

Foundations, piers and approach retaining walls (not including cement)	$ 44,623
Cement, 18,623 bbl. @ 1.25	23,279
Total Foundations, Piers and Walls, exclusive of earth fill	$ 67,902

The earth fill between walls in approaches was included in a separate grading contract with other grading, and is not included in costs here given.

Superstructure:

Class X concrete (not including cement), 1,298.2 cu. yd. @ 17.64	$ 22,900
Reinforcing steel, 225,210 lb. @ 0.031	6,982
Structural steel, 1,515,047 lb. @ 0.0412	62,420
Name plate	39
Cast iron, 51,607 lb. @ 0.065	3,354
Wire fabric, 4,638 sq. ft. @ 0.034	158
Nuts and bolts, 630 lb. @ 0.098	62
Blast plates, 9,910 lb. @ 0.065	644
Drain tile, 3,508 lin. ft. @ 0.309	1,084
Extras:	
Two stairways (not including cement)	2,390
Pipe rail on stairways	1,104
Electrical work	2,490
Miscellaneous	799
Cement, 2,078¼ bbl. @ 1.25	2,598
Total Superstructure	$107.024
Total Cost of Viaduct, exclusive of earth fill in approaches	$174,926
Cost per lineal foot of viaduct and approaches	$132

MANNHEIM ROAD (U. S. ROUTE 45) OVER NORTH AVENUE (STATE ROUTE 64)

(Photo April 26, 1935)

Reinforced concrete girders with center pier, over walled subway.

Unpaved center strip in subway is to be parked. Parking will be displaced by pavement when required by traffic.

Drainage by automatic pumping equipment housed under roadway behind abutment wall of bridge; discharge to Addison Creek through 3,000 feet of 30 inch storm sewer.

2 Concrete girder spans, 46 ft. each	92 *ft.*
Pier thickness	4 *ft.*
Clear Distance between Subway Walls	96 *ft.*
Width of bridge pavement	44 *ft.*
2 sidewalks, 6 ft. each	12 *ft.*
Total Width of Bridge between Handrails	56 *ft.*
Total Length of Subway	969 *ft.*

Constructed 1931.

Cost of Subway and Bridge

Class X concrete (including structural excavation but not including cement), 3,349.5 cu. yd. @ 16.71	$ 55,970
Tile encasement concrete, class X, 24 cu. yd. @ 23.54	565
Reinforcing steel, 319,036 lb. @ 0.032	10,209
Structural steel, 3,648 lb. @ 0.056	204
Rockers and plates, 7,392 lb. @ 0.047	347
Name plate	47
Structural tile, 1,066 sq. ft. @ 0.28	298
Wire fabric, 1,515 sq. ft. @ 0.038	58
Pump units, complete, 2 @ 1,408.83	2,818
Catch basins, standard, 4 @ 42.37	169
Catch basins and manholes, special, 4 @ 94.16	377
Cast iron pipe, 10 in., 55 ft. @ 4.71	259
Lighting system, complete	682
Bridge pavement, 4 in., 477 sq. yd. @ 0.94	448
Cement, 6,420 bbl. @ 1.25	8,025
Extras:	
Lowering footings due to change in plans	2,655
Power line to pump house	823
Miscellaneous	1,734
Total Cost exclusive of Grading and Pavement	$ 85,668
Grading, paving (including 4 side connections between Routes 45 and 64), storm sewer to Addison Creek (3,000 ft.), and miscellaneous items, not including cement	$ 97,488
Total Cost of Separation Exclusive of Cement Used in Pavement	$183,156

ONE HUNDRED TWENTY-THIRD STREET AND EIGHTY-SIXTH AVENUE OVER SOUTHWEST HIGHWAY (STATE ROUTE 7) AT PALOS PARK

(Photo April 30, 1935, showing One Hundred Twenty-third Street Separation Only)

Plate girder bridges, concrete retaining walls and miscellaneous appurtenant construction.

One Hundred Twenty-third Street Bridge:
Skew 40° 03'
Girder length, c to c of pins ..... 74 *ft.* 4 *in.*
Clear opening face to face of abutments ..... 44 *ft.* 4 *in.*

Roadway width, 123rd St ..... 42 *ft.* 0 *in.*
Curbs and girder tops, 2 @ 1 ft. 9 in. ..... 3 *ft.* 6 *in.*
Sidewalks, 2 @ 6 ft. 6 in ..... 13 *ft.* 0 *in.*

Total Width of Bridge ..... 58 *ft.* 6 *in.*
Horizontal Area ..... 4,348 *sq. ft.*

Eighty-sixth Avenue Bridge:
Girder length, c to c of pins ... 65 *ft.* 2¾ *in.*
Total width ..... 58 *ft.* 6 *in.*
Horizontal Area ..... 3,816 *sq. ft.*
Constructed by Cook County 1930.

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Cost of Two Bridges and Appurtenant Construction

Concrete, Class X (not including cement), 205.61 cu. yd. @ 20.00	$ 4,112
Reinforcing bars, 244,922 lb. @ 0.04	9,797
Cast iron rockers, 5,493 lb. @ 0.07	385
Steel bearing plates, 2,360 lb. @ 0.07	165
Name plates, 4 @ 31.00	124
Excavation, Class A, 15,036 cu. yd. @ 0.70	10,525
Borrow, 7,577 cu. yd. @ 0.90	6,819
Crushed stone roadway, 1,388.64 cu. yd. @ 2.50	3,472
Combination curb and gutter, 1,379 lin. ft. @ 0.55	758
Excavation, Class B, 620 cu. yd. @ 0.50	310
Concrete, Class A (not including cement), 161.6 cu. yd. @ 12.00	1,939
Concrete, Class A—Headwalls (not including cement), 2,424.1 cu. yd. @ 16.00	38,786
Oak headers, 446 lin. ft. @ 0.60	268
Excavation and back fill, 7,963 cu. yd. @ 1.50	11,944
Pipe drain, 3 in. vit. tile, 384 lin. ft. @ 0.30	115
Pipe drain, 6 in. vit. tile, 2,192 lin. ft. @ 0.50	1,096
Corrugated iron pipe, 15 in., 46 lin. ft. @ 2.00	92
Bituminous felt, 1 in., 84 sq. ft. @ 0.50	42
Bituminous felt, 2 in., 84 sq. ft. @ 1.00	84
Bituminous felt, ½ in., 3,554.5 sq. ft. @ 0.25	889
Structural steel, 348,430 lb. @ 0.05	17,422
Pipe railing, 1,204 lin. ft. @ 3.00	3,612
Concrete gutter, 3,340 lin. ft. @ 0.50	1,670
Vitrified tile, 24 in., 700 lin. ft. @ 3.00	2,100
Vitrified tile, 18 in., 226 lin. ft. @ 3.50	791
Vitrified tile, 15 in., 924 lin. ft. @ 2.00	1,848
Catch basins, 12 in., 6 @ 20.00	120
Catch basins, 24 in., 15 @ 35.00	525
Inlets, 15 in., 2 @ 30.00	60
Concrete pavement, 13,132.6 sq. yd. @ 1.80	23,639
Shoulders, 5,678 sq. yd. @ 0.15	852
Section markers, 2 @ 25.00	50
Guard fence, 550 lin. ft. @ 1.00	550
Extras	5,630
Cement	15,881
Total Cost of Two Separations	$166,472

SOUTHWEST HIGHWAY (STATE ROUTE 7) OVER MANNHEIM ROAD (U. S. ROUTE 45) AT ORLAND PARK

(Photo April 30, 1935)

Plate girders on concrete abutments.
Skew 41° 49'.
Length of girders ..... 75 *ft.* 0 *in.*
Clear distance between abutments ..... 50 *ft.* 0 *in.*
Depth of girders ..... 7 *ft.* 0½ *in.*

Width of bridge pavement ..... 44 *ft.* 0 *in.*
1 Sidewalk ..... 4 *ft.* 6 *in.*

Total Width Roadway and Walk ..... 48 *ft.* 6 *in.*
Horizontal Area ..... 3,638 *sq. ft.*

Constructed by Cook County—1930.

Cost of Bridge

Class A concrete (not including cement) 809 cu. yd. @ 17.50	$14,158
Reinforcing steel, 99,614 lb. @ 0.05	4,980
Cast iron rockers, 3,850 lb. @ 0.08	308
Steel bearing plates, 1,250 lb. @ 0.08	100
Pipe hand rail, 219 lin. ft. @ 3.50	766
Name plates, 2 @ 50.00	100
Rein. concrete pipe (48 in.) 385 lin. ft. @ 10.00	3,850
Corrugated iron pipe (36 in.) 250 lin. ft. @ 10.00	2,500
Approach grading-borrow, 46,302 cu. yd. @ 0.75	34,726
Class X concrete, 111.8 cu. yd. @ 40.00	4,472
Structural steel, 178,135 lb. @ 0.06	10,688
Excavation and back fill, 1,351 cu. yd. @ 3.00	4,053
Partition tile (6 in.), 324 sq. ft. @ 0.30	97
Wire mesh, 446 sq. ft. @ 0.05	22
Treated piling, 5,700 lin. ft. @ 1.25	7,125
Vitrified pipe (6 in.), 330 lin. ft. @ 0.50	165
Earth shoulders, 667 sq. yd. @ 0.20	133
Extras:	
Removing and replacing tile around abutments	737
Placing CB and bulkheads at bridge	737
Repairing well	579
Additional work protecting expansion devices	145
Cement, 1,546 bbl. @ 1.69	2,613
Total Cost of Bridge and Approaches	$93,056

NORTHWEST HIGHWAY (U. S. ROUTE 12) OVER STATE ROUTE 58 AT CUMBERLAND

(Photos April 20, 1935)

Upper View: The separation as seen from board walk leading to railway station. Pedestrian tunnel at left is reached by concrete-inclosed stairway at north corner of bridge. Ends of concrete cribbing shown at left edge of picture.

Lower View: Chicago and Northwestern Ry. crossing over graded but unpaved Route 58 at Cumberland Station. Portions of the Northwest Highway bridge are visible above and below the railway bridge. Stairway railing is visible at left as an extension of bridge handrail. Stairways and a walk under Northwest Highway and the railway tracks connect with the railway station, which is located to the left beyond the limits of the picture. Note that the ground at left side of cut is supported by retaining wall and cribbing, while that at the right is sloped back. Gravity drainage is provided by 775 ft. of 24 in. pipe to Welles Creek.

Reinforced concrete girders, clear span ..... 44 *ft.*
Pedestrian tunnel—clear width ..... 6 *ft.*
Approximate total length of bridge ..... 58 *ft.*

Roadway width ..... 54 *ft.* 6 *in.*
1 *Sidewalk* ..... 6 *ft.* 0 *in.*

Total Width of Bridge Roadway and Walk ..... 60 *ft.* 6 *in.*
Approximate Horizontal Area ..... 3,509 *sq. ft.*

Construction Completed June, 1934.

Cost of Bridge and Appurtenant Construction

(Cost includes walls, walk, and all other structural items up to the railway right of way.)

Earth excavation, 16,983 cu. yd. @ 0.40	$ 6,793
Rock excavation, 44.7 cu. yd. @ 2.75	123
Sand, gravel or crushed stone back fill, 1,105 cu. yd. @ 2.25	2,486
Concrete pavement, 4 in., 332 sq. yd. @ 1.00	332
Woven wire fabric, 420 sq. ft. @ 0.05	21
Wall tile, 260 sq. ft. @ 0.30	78
Reinf. concrete pipe, 18 in., 176 lin. ft. @ 2.31	407
Reinf. concrete pipe, 12 in., 72 lin. ft. @ 1.75	126
Single pipe rail, 52 lin. ft. @ 1.60	83
Triple pipe rail, 60 lin. ft. @ 4.00	240
Hand rail concrete, 76.1 cu. yd. @ 35.00	2,664
Class X concrete (not including cement), 1,501.5 cu. yd. @ 15.76	23,664
Reinforcing bars, 207,524 lb. @ 0.034	7,056
Structural steel, 1,760 lb. @ 0.12	211
Rockers and plates, 2,730 lb. @ 0.07	191
Reinf. concrete storm sewer, 24 in., 775 lin. ft. @ 3.50	2,712
Tile drain, 8 in., 210 lin. ft. @ 0.94	197
Catch basins and frames, 6 @ 71.50	429
Manholes, 5 @ 90.00	450
Special inlets, 6 @ 26.75	160
Special inlets, 3 @ 41.00	123
Extras:	
Lowering water main	1,047
Building crib walls	2,208
Paving gaps on each side of bridge	774
Miscellaneous	1,006
Cement, 2,704 bbl.	4,127
Total Cost of Bridge and Appurtenant Construction	$57,708

BLUE ISLAND RIVERDALE ROAD OVER ASHLAND AVENUE (STATE ROUTE 49)

(Photo April 30, 1935)

Reinforced concrete girders on concrete piers and abutments.
Main span ..... 45 *ft.*
2 *Approach Spans, 7 ft. 6 in each* ..... 15 *ft.*

Total Clear Openings ..... 60 *ft.*
Distance face to face of abutments ..... 67 *ft.*

Width of bridge pavement ..... 44 *ft.*
2 *Sidewalks, 6 ft. each* ..... 12 *ft.*

Clear width of bridge between handrails ..... 66 *ft.*
Horizontal Area ..... 4,422 *sq. ft.*
Contract Awarded April, 1934.

Note 2 plate girder railway bridges in background. Pictures and costs of these were given in R. & S. for May.

Cost of Bridge

Class X concrete (not including cement), 838.7 cu. yd. @ 15.00	$12,580
Handrail concrete (not including cement), 9.4 cu. yd. @ 40.00	376
Reinforcement bars, 125,010 lb. @ 0.034	4,250
Structural steel, 3,516 lb. @ 0.06	211
Rockers and plates, 3,670 lb. @ 0.062	228
Welded wire fabric, 834 sq. ft. @ 0.04	33
Hollow floor or wall tile, 717 sq. ft. @ 0.23	165
Cement, 1,459 bbl. @ 2.43	3,545
Concrete pavement (4 in.), 328.7 sq. yd. @ 0.75	247
Extras	540
Total Cost of Bridge	$22,175
Cost per square foot horizontal area	$5.00

ARCHER AVENUE (STATE ROUTE 4A) OVER MANNHEIM ROAD (U. S. ROUTE 45)

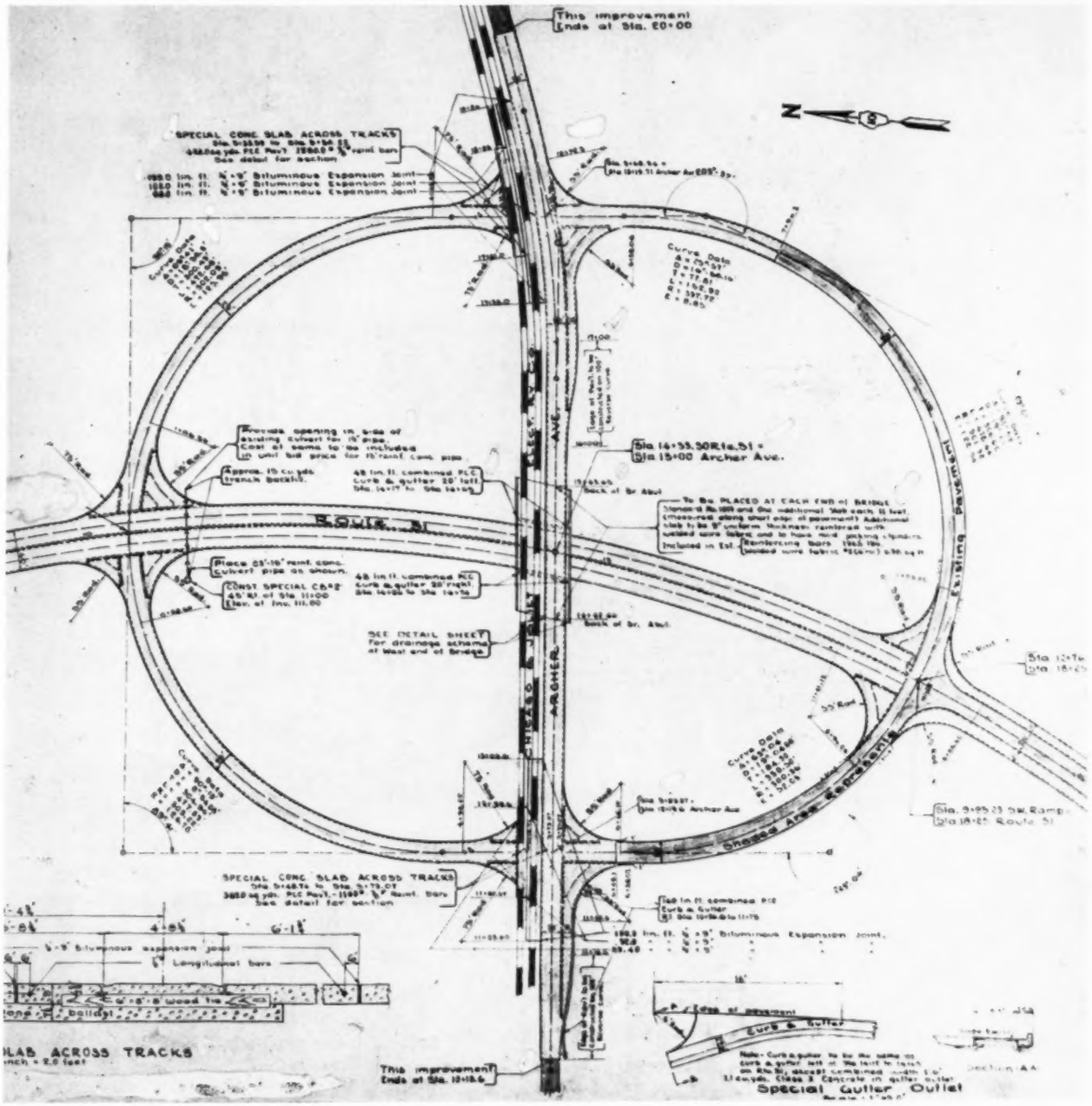
(Photo April 26, 1935)

Reinforced concrete girders with concrete piers.

Main span	44 *ft.*
East approach span	36 *ft.*
West approach span	30 *ft.*
Total Length of Bridge	110 *ft.*
Highway width	24 *ft.*
Width for double track electric railway (now abandoned and unpaved)	24 *ft.*
Total Width, Usable Bridge Surf.	48 *ft.*
Horizontal Area	5,280 *sq. ft.*

The north side (shown in photo) was designed for electric railway tracks, and has heavier and deeper girders than the south side. South side is provided with standard concrete handrail.

Construction Completed February, 1932.



Plan of Grade Separation and Connecting Ramps at Archer Avenue and Mannheim Road

Cost of Bridge

Concrete, Class X (not including cement), 917.16 cu. yd. @ 18.50	$16,967
Reinforcing steel, 146,694 lb. @ 0.0375	5,501
Structural steel, 2,500 lb. @ 0.10	250
Rockers and plates, 11,490 lb. @ 0.10	1,149
Name plate	15
Pavement surface, 319.9 sq. yd. @ 1.25	400
Miscellaneous	167
Extras:	
Engineering	438
Excavation	476
Bituminous joint, 250 ft. @ 0.10	25
Cement, 62½ bbls. @ 1.25	78
Rubbing underside of 3 spans	657
Cement	2,180
Total Cost of Bridge	$28,303
Cost per square foot horizontal area	$5.35

STATE ROUTE 52 OVER MANNHEIM ROAD (U. S. ROUTE 45)

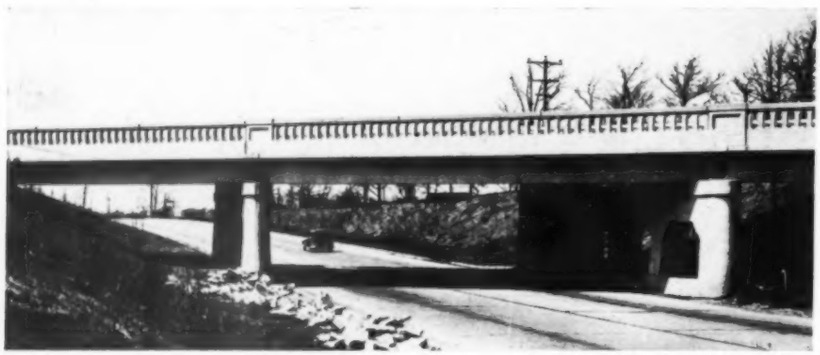
(Photo April 30, 1935)

Reinforced concrete arched girder:
Clear span measured on skew..60 ft. 1⅞ in.
Clear span at right angle to abutments ..... 60 ft. 0 in.
Clear width of bridge between handrails ..... 44 ft. 4 in.
Horizontal Area ..... 2,667 sq. ft.
Footings on solid rock about 9 ft. deep.
Soil over rock was an old peat deposit.

Contract awarded May, 1932.
Bridge completed September, 1932.

Cost of Bridge

Rock excavation, 106.3 cu. yd. @ 15.00	$ 1,595
Class X concrete (including structural excavation in earth but not including cement), 965.2 cu. yd. @ 15.20	14,575
Reinforcing steel, 139,610 lb. @ 0.028	3,909
Rockers and plates, 4,505 lb. @ 0.07	315
Lighting system	275
Name plate	25
Cement, 1,535 bbl.	1,213
Total Cost of Bridge	$21,907
Cost per square foot horizontal area	$8.22



DUNDEE ROAD OVER NORTHWEST HIGHWAY (U. S. ROUTE 12)

(Photos April 20, 1935)

Upper: General view from the south, showing connecting ramps. The ramp at left is a part of the old pavement of Northwest Highway prior to elimination of the grade crossing. Extensive landscaping is in progress on both sides of the bridge.

Northwest Highway at this point is closely paralleled by Chicago and Northwestern Railway. Dundee Road crosses the railway on a bridge built several years before the highway grade separation, and located to the left just beyond the limits of the picture. As the railroad is located in a fairly deep cut, no raise of highway grade is necessary for the overhead crossing.

Lower: A close-up of the bridge from the south. The handrail shows the standard design used by the Illinois Division of Highways on most of its bridges. The round-ended piers are used less commonly.

Bridge consists of 3 reinforced concrete girder spans, each 59 ft. 3 in. long. Total length 177 ft. 9 in.

Roadway width	44 ft.
Sidewalk	6 ft.
Total width of bridge between handrails	50 ft.

Construction completed 1931.

U. S. ROUTE 20 OVER NORTH AVENUE (STATE ROUTE 64) NEAR DU PAGE COUNTY LINE

(Photo April 26, 1934)

Steel pony trusses on concrete pier and abutments, with concrete approach walls. Note extreme skew.

German Express Highway Under Construction. This Typical Section Provides for a Center Lawn Strip 15 Feet Wide, with a Pavement 25 Feet Wide, Consisting of Two Traffic Lanes on Either Side Bordered by Shoulders. Note the Planting of Trees and Shrubbery on Center Strip.

GERMANY BUILDS EXPRESS HIGHWAYS

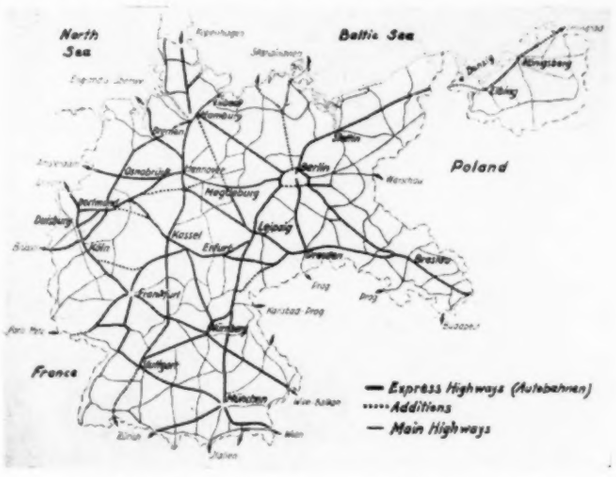
By ERNEST ZUBE

Junior Physical Testing Engineer, Materials and Research Department of the California Division of Highways.

WHILE on a visit to Germany during the past year, I was afforded the opportunity to make some observations regarding the road building and material testing methods employed by that country. As these observations may be of interest to the readers of ROADS AND STREETS, the following brief outline of the highway situation, together with notes on various laboratories, is given.

Germany Has 140,000 Miles of Highways—Germany, in area somewhat larger than California, with a population of about one-half of that of the United States, has approximately 140,000 miles of highways. These highways in former years consisted mostly of water-bound macadam or some type of stone pavement. The ever-increasing automobile travel has made it imperative that these old roads be improved with some sort of smooth, wear-resistant surface. Consequently, the problem within the last few years has been one of improving and maintaining these roads, rather than one of new construction. Due to the fact that bituminous surfaces are still three to four times as expensive as in the United States, the improvements could not be carried out as might be desired, and a light surface treatment is frequently the best that can be afforded. Penetration methods, emulsions, and sheet asphalt (for city streets) are used extensively.

Gasoline and tires are still quite expensive in Germany, and the majority of the people cannot afford to own and operate automobiles to the degree that is prevalent in this country. As a part of the general program to stimulate further automobile travel, and provide the country with rapid and more direct transportation facili-



Map Showing Planned Express Highway System.

Preparation of Telford Base for Asphaltic Concrete.

ties, the government now has under construction a system of express highways, which are to serve as the main arteries between the larger cities. By eliminating frequent stops and slow-downs, there is a decided advantage from the economic point of view.

5,000 Miles of Express Highways Under Construction—These highways are especially designed to avoid the close-together, congested communities. As most German cities are old, and many of the buildings are of considerable historic value, a general widening of the narrow streets would be undesirable. Therefore, the construction of these Express Highways was considered a better plan than to rebuild the existing system, and construct by-passes to avoid these communities. Furthermore, the numerous detours around cities would have really increased the traveling distance.

At present, the building of these express highways (Autobahnen) is the most important work in German highway construction. The first unit (now under way) consists of approximately 5,000 miles, of which about 1,000 miles are finished. Approximately 80,000 men, exclusive of those employed in allied industries, have been taken from the relief rolls and put to work, with hand labor employed whenever feasible.

After the completion of this construction program, a large increase in automobile travel is expected, and it may be of interest to note that the registration for new automobiles in 1933 was double that of 1932, and 1934 showed a further substantial increase. The recent abolishment of all government taxes in connection with the purchase of new automobiles was a further incentive to a greater distribution of motor vehicles.

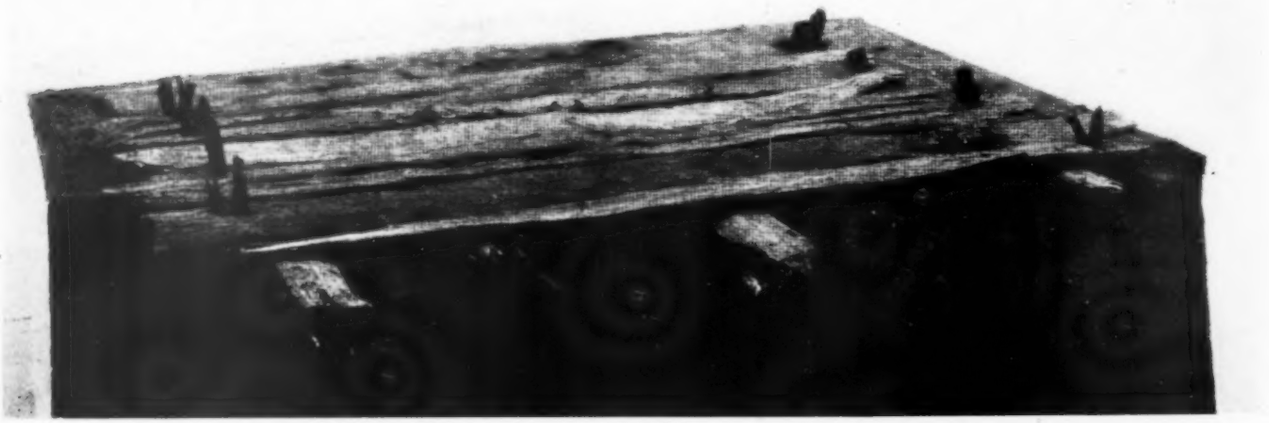
Design and Construction Feature of Express Highways—These highways are designed to follow a straight line as nearly as possible. However, to relieve the fatigue of the driver, slight curves are provided at intervals of about three miles. The auto roads are being built for high speeds, and the curves are designed for speeds up to 120 miles per hour. The maximum allowable grade is 4 per cent, and the minimum radius used for curves is 5,000 ft.

The typical cross-section shows a center lawn strip, 15 ft. wide, with a pavement 25 ft. wide, consisting of two traffic lanes on either side, bordered by shoulders. The pavement consists of either bituminous surfaces or portland cement concrete. Because of frost action in the winter time, great care is taken with the construction of the subgrade. Due to the fast speeds, the surfaces are of exceptionally heavy construction. A cross-section of one of these concrete roads consists of approximately 3 to 4 in. of gravel spread upon the subgrade, 5 in. of rather porous lean concrete, a 6-in. course of a little better grade of concrete, followed by a 3-in. surface course, with a wire mesh between the last two courses. The bituminous surfaces are constructed either on a lean portland cement concrete base or on a telford base, and are designed according to the void theory, attempting to produce a minimum of voids (2 per cent-4 per cent).

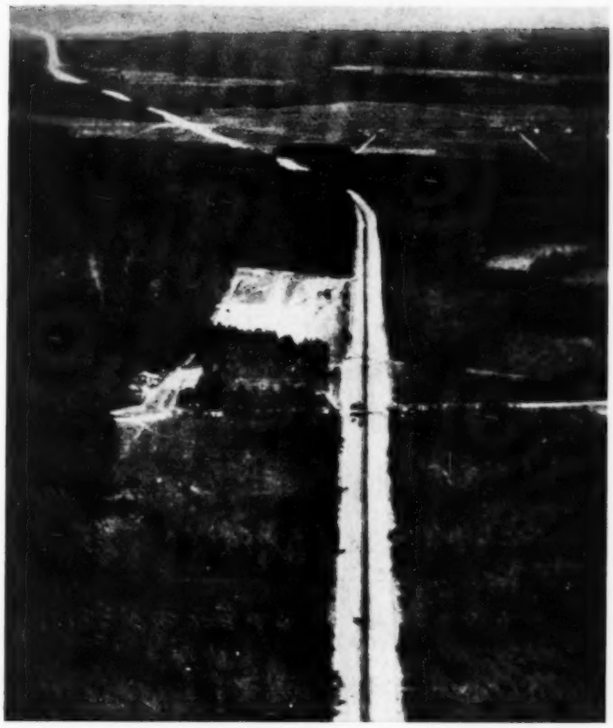
Construction Difficulties Encountered—In some sections, as in East Prussia, where these express highways pass through marshlands, considerable construction difficulties are encountered. In some cases the existing mud has been excavated to a depth of 30 feet and replaced with a suitable material, which is hauled in by train a long distance. The resulting embankment will also eliminate the accumulation of snow on the highway, as the snowfall is especially heavy in this section. As rivers are also numerous here, a short stretch of 45 miles requires a total of about 100 bridges and viaducts, some of considerable length.

Landscaping the Highways—These roads are being beautified by planting trees and shrubbery on the center strip and along the edges of the shoulders, species being selected that reflect light readily from the autos. The shrubbery on the center strip also tends to protect the driver from the glaring headlights of cars traveling in the opposite direction, especially on vertical curves.

In the design of these roads, much thought and effort is given to make motor traveling as attractive as possible. Densely wooded areas are relieved at intervals by small clearings or views of distant landscapes. In sections lacking in natural beauty, the occasional planting of small tree groups, bushes, or hedges will serve to relieve the monotony of the trip.



Old Germanic Plank Road Built About 1000 *B. C., Excavated in* 1934 *Near Bremen.*



Express Highway Near Munich.

In very mountainous sections, such as the Bavarian Alps, the highway will sometimes be a one-way road, in that the descending journey follows a different route. This affords the motorist the opportunity to view the greatest possible variation in mountain scenery, and also reduces construction costs and increases safety.

Highways Will Have No Grade Crossings—The express highways will be absolutely free from grade crossings and intersections—viaducts or subways being provided to permit a continuous fast and safe travel. Elaborate systems are worked out for the crossing of highways (braided intersections) to permit the transfer of a machine from one highway to another. The roads will also be illuminated, and experiments are being carried on at present with several different systems of lighting. The yellowish light of sodium vapor lamps, which is considered superior to white light in fog, appears to be the most promising. A stationary lighting system will prove advantageous, as the same speed may be maintained at night as during the daytime.

Pavements in Smaller Cities—The pavement in the smaller cities still consists mostly of some type of stone pavement; in fact, a modern pavement within these century-old surroundings might be somewhat incongruous. In the larger cities and suburbs, where a considerable amount of horse-drawn vehicles are still encountered, sheet asphalt or asphaltic concrete, with a maximum aggregate up to ⅜ in., is constructed. A close, dense wearing course is necessary to prevent any damage caused by the digging action of the horses' hoofs.

Several special processes, such as rolling with corrugated rollers, etc., are used to prevent slippery surfaces on sheet asphalt. Stone pavement, consisting of small hewn granite blocks, 2 to 3 in. square, laid in arch-shaped courses, is also used a great deal. This presents a smooth, non-skid and satisfactory pavement for motor vehicle traffic.

Almost without exception, all existing roads are lined with trees; and roughly split rocks, painted white, about 16 in. high, are set along the edges of the shoulders for guidance.

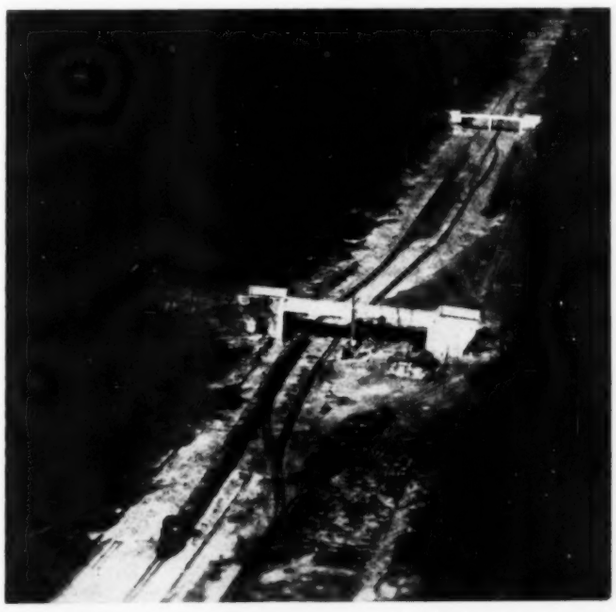
The chief means of transportation in Germany is still the government-owned railroad, which in a spider web fashion covers the entire country; and the railroad station in the larger cities is an important and frequently a pretentious building. The resulting numerous grade crossings and the large number of daily trains make it necessary to have crossings protected by gates tended by gatemen.

Bicycle Roads—While traveling in Germany, one is impressed with the multitude of bicycles, which, ridden by all types of people, frequently present a rather amusing sight, at least to a stranger. Approximately one-sixth of the population own bicycles. The traffic officer in directing traffic considers bicycles on a par with automobiles. Several of the larger cities are provided with bicycle roads, thereby greatly reducing the accident hazard. Some highways include a separate strip for bicycle traveling. At present there is a movement on foot to promote the building of extensive bicycle roads, especially to points of interest and recreational centers, such as the valley of the Rhine and the mountain regions.

Tests of Road Building Material—The materials intended for road building purposes are investigated very thoroughly and subjected to a good many tests. Quite often the proposed method and material is tried out in test tracks which duplicate actual conditions. The slogan seems to be "Foresight is better than aftersight."

Especially noteworthy is the test track at Braunschweig, which is built and maintained by the Germany highway construction organization (D. St. B. V.). The track is about 1,000 ft. in diameter; and besides the testing of different types of surfaces under traffic conditions, various other factors are studied, such as the effect of different types of tires, velocities of vehicles, abrasion of surface, etc.

Besides the government testing laboratory at Berlin, there are at least a dozen university laboratories, with highly trained personnel, entrusted with the testing of road building materials. The routine testing of samples, in addition to our methods, includes special determinations such as brittle point, stiffness point, and drip point for bituminous materials; also compression, tension and elongation, permeability, penetration, sand blast, and



Express Highway Under Construction (Heidelberg-Mannheim).

other abrasion tests for the wearing course. Extensive research investigations such as influence and fineness of filler materials, adsorptive qualities of aggregate, colloidal composition of asphalts, determination of friction and resistance offered to skidding of different types of pavements, cohesive qualities of asphalts, breakdown values of emulsions, etc., are also carried on by the laboratories.

My itinerary in Germany took me through Bremen, with its old city hall, built almost a hundred years before the discovery of America, up the historic Rhine to the Universities of Karlsruhe and Stuttgart. Both university laboratories are equipped with circular test tracks for the testing of road material under conditions comparable to actual traffic. The accompanying picture shows the elaborate test track at the University of Karlsruhe. The track is about 70 ft. in diameter, utilizing a test road of from 6 to 10 ft. wide; a side adjustment permits the wheels to cover the entire surface.

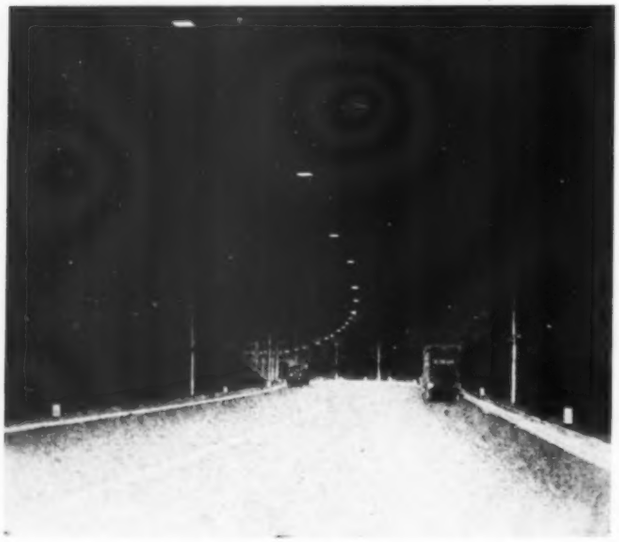
A stop was also made at Munich, where in connection with the International Road Congress of 1934, an exhibit, "The Street" ("Die Strasse") was held. The evolution of roads, beginning with an excavated portion of an old Germanic plank road built about 1000 B. C., and examples of various periods up to the present were shown in pictures, graphs, and models.

All types of apparatus for the chemical and physical testing of road materials, together with considerable equipment for determining tire friction and slab vibrations of different pavements, were exhibited.

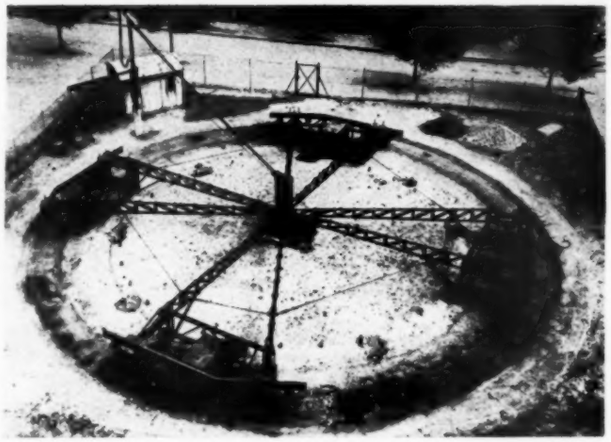
Also very interesting was an electrically operated model showing the different proposed lighting systems for the new express highways. By pressing a button, one can view in sequence the illumination of the road by daylight, then in the slowly approaching darkness the illumination by automobile headlights, followed by the various contemplated stationary lighting systems.

The university laboratories of Dresden, Berlin, and the Free City of Danzig were also visited. At the latter, the testing of materials is performed for the eastern section of Germany, which is separated from the rest of Germany by the Polish Corridor. This corridor will present an obstacle to the through traffic from one part of Germany to the other, but undoubtedly some satisfactory solution will be worked out.

After the completion of this first unit of express highways, further additions will be planned. Germany will have reason to be proud of its motor traveling facilities.



Experimental Road Illumination with Sodium Vapor Lamps.



Elaborate Test Tracks Equipped for the Testing of Road Materials Under Conditions Comparable to Actual Traffic Are Used by German Highway Laboratories. The Track Is About 70 Feet in Diameter, Utilizing a Test Road of from 6 to 10 Feet Wide. A Side Adjustment of the Apparatus Permits the Wheels to Cover the Entire Surface.

Longest Street in United States Cities

Figuerosa street, Los Angeles, Calif., with a length of 27.5 miles is the longest street in any city in the United States, according to a tabulation compiled by Frederick Rex, Librarian, Municipal Reference Library, Chicago. Western avenue, Chicago, is the second longest street. Mr. Rex points out, however, that Western avenue, while having a length of 23.5 miles within the city of Chicago, still has a much greater length, because it begins at approximately the south boundary line of Cook County, continues through the city of Chicago for a distance of 23.5 miles, and then north to Emerson street in the city of Evanston, or a total length of 40 miles.

The mileage of important streets in cities of the United States follows:

Name of Street and City	*Miles in Length*
Figuerosa Street, Los Angeles	27.5
Western Avenue, Chicago	23.5
Vermont Avenue, Los Angeles	22.8
Halsted Street, Chicago	21.275
Ashland Avenue, Chicago	21.125
Ventura Boulevard, Los Angeles	20.5
Seven Mile Road, Detroit	19.8
Kedzie Avenue, Chicago	19.5
Crawford Avenue, Chicago	18.0
Eight Mile Road, Detroit	17.9
State Street, Chicago	17.0
Six Mile Road, Detroit	15.9
Broadway, New York City	14.5
Grand River Avenue, Detroit	14.2
Hylan Boulevard, New York City	13.0
Roosevelt Boulevard, Philadelphia	12.0
Broad Street, Philadelphia	11.5
Frankford Avenue, Philadelphia	11.5
Livernois Street, Detroit	10.75
St. Clair Avenue, Cleveland	10.17

▼

LAREDO-MEXICO CITY HIGHWAY TO BE OPENED IN JUNE.—The Highway Department of the Ministry of Public Works and Communications of Mexico has announced definitely that the Mexico City-Laredo, Texas, section of the Inter-American Highway will be opened to traffic during the month of June this year, according to a report from Acting Commercial Attache Horton Henry, Mexico City. Work on the unfinished sections between Monterrey and Mexico City is being pushed rapidly with the aid of 10,000 workmen and three large power shovels.

By A. B. GREENLEAF
Field Editor,
ROADS AND STREETS

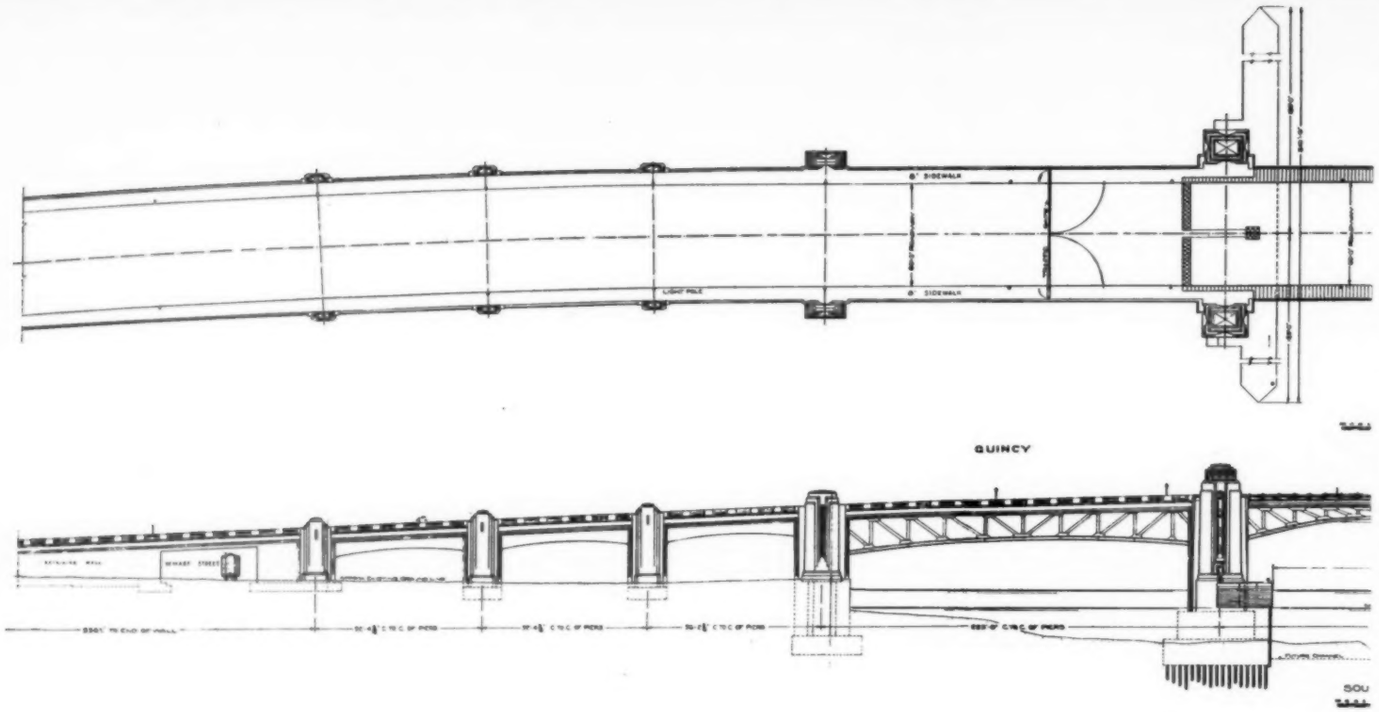
THE WEYMOUTH FORE RIVER BRIDGE

WITH the possible exception of the Tri-borough bridge in New York and the San Francisco-Oakland bridge in California, it would be difficult to find a more interesting road bridge under construction in the United States this summer than the Weymouth Fore River bridge near Quincy, Massachusetts.

Location.—The Weymouth Fore River bridge spans Weymouth Fore River, connecting the city of Quincy and the town of Weymouth, but its importance as a traffic artery is that it is on the main route connecting Metropolitan Boston with Nantasket Beach, Plymouth, and the south shore. The river traffic is important and much of the shipping is dependent on the draw in the bridge for access to the sea. The old bridge had a roadway of 30-ft. width which included a single track of the Eastern Massachusetts Street Railway Company. A 7-ft. sidewalk also laid adjacently and to the east of the roadway. The total length of the old structure between abutments was 672 ft. It was made of two plate girder spans, a swing type, through truss draw span providing two 125-ft. clear channels for shipping, and four plate girder spans connecting the draw with the Weymouth shore. These plate girder spans were supported on cylindrical piers, each pier consisting of two 6-ft. diameter cast-iron cylinders filled with concrete and braced together. The draw span rested on a 30-ft. diameter cylindrical pier of concrete masonry faced with granite. The surface of both roadway and sidewalk was of wood, the roadway being reinforced with four lines of steel traffic treads.

Replaced Still Older Bridge.—This old bridge replaced a still older one built in 1901-1902. In 1910 this older bridge went under general repairs including the lengthening of the draw span to provide the openings of 125 ft. possessed by the subsequent structure. Repairs on the old bridge were frequent and costly in more ways than one. The structure built in 1901-1902 was posted for six tons, together with the street cars. At the time it became apparent that a new bridge was imperative the roadway surface of wood was in poor condition and required constant repairing. The average cost of maintenance per year for the ten years previous to its removal was $13,500.

Highway Traffic.—Since the Fore River bridge is on the principal route from Metropolitan Boston to the south shore beaches, the density of traffic reaches its peak on summer Sundays and holidays. A typical traffic count taken on a Saturday showed that over a period of 16 hours, a total of 32,173 vehicles passed over the bridge. This condition was continuously aggravated by street car traffic which cut off at least 30 per cent of the space ordinarily used by other vehicles. Added to this was the aggravation caused by the frequent opening of the draw, which blocked traffic over long periods of time and for long distances on either side of the bridge. A recent study of the probable increase in traffic made by the Division of Metropolitan Planning indicates that by 1965 the volume will be 100 per cent greater than in 1933 which would be about 65,000 vehicles a day. Such traffic would require a bridge 60 ft. in width.



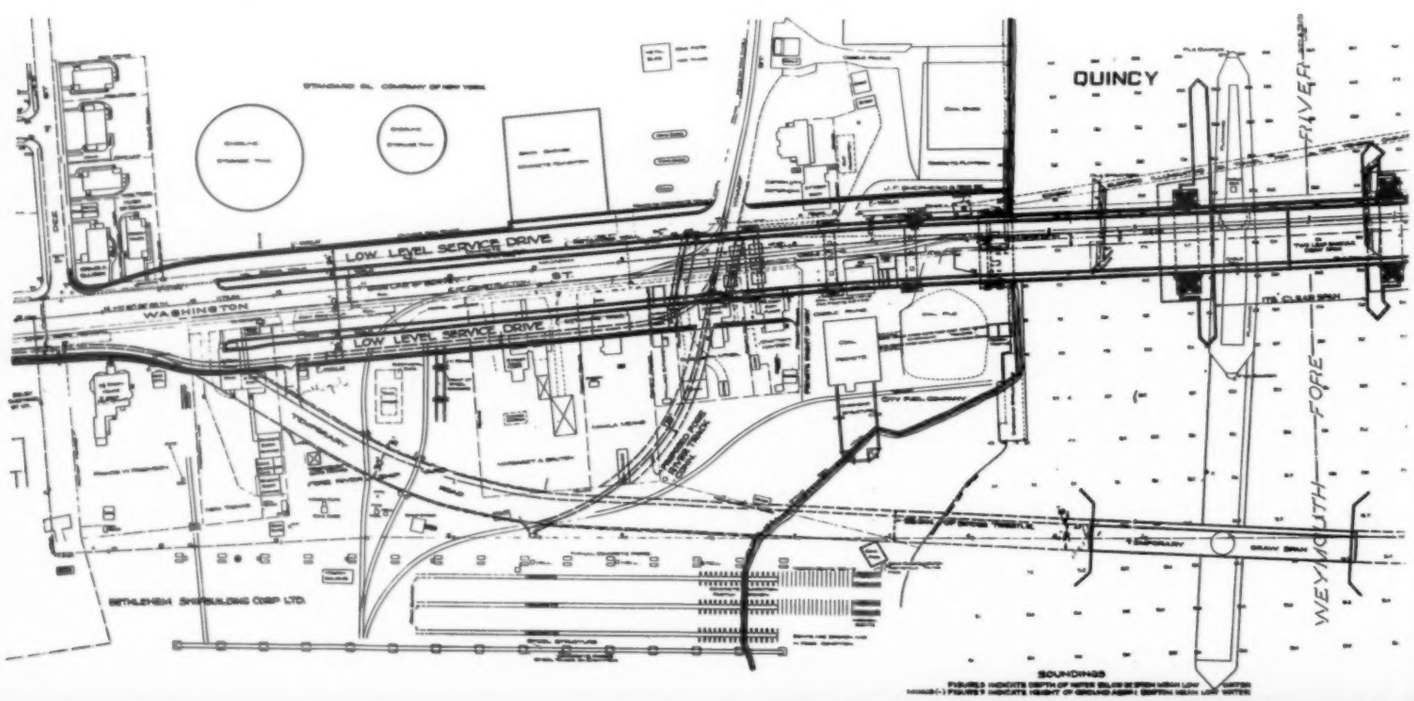
River Traffic.—Water-borne traffic necessitates an average of about seven draw openings a day. The following are the bridge tenders' records of openings for the years 1907 to 1930:

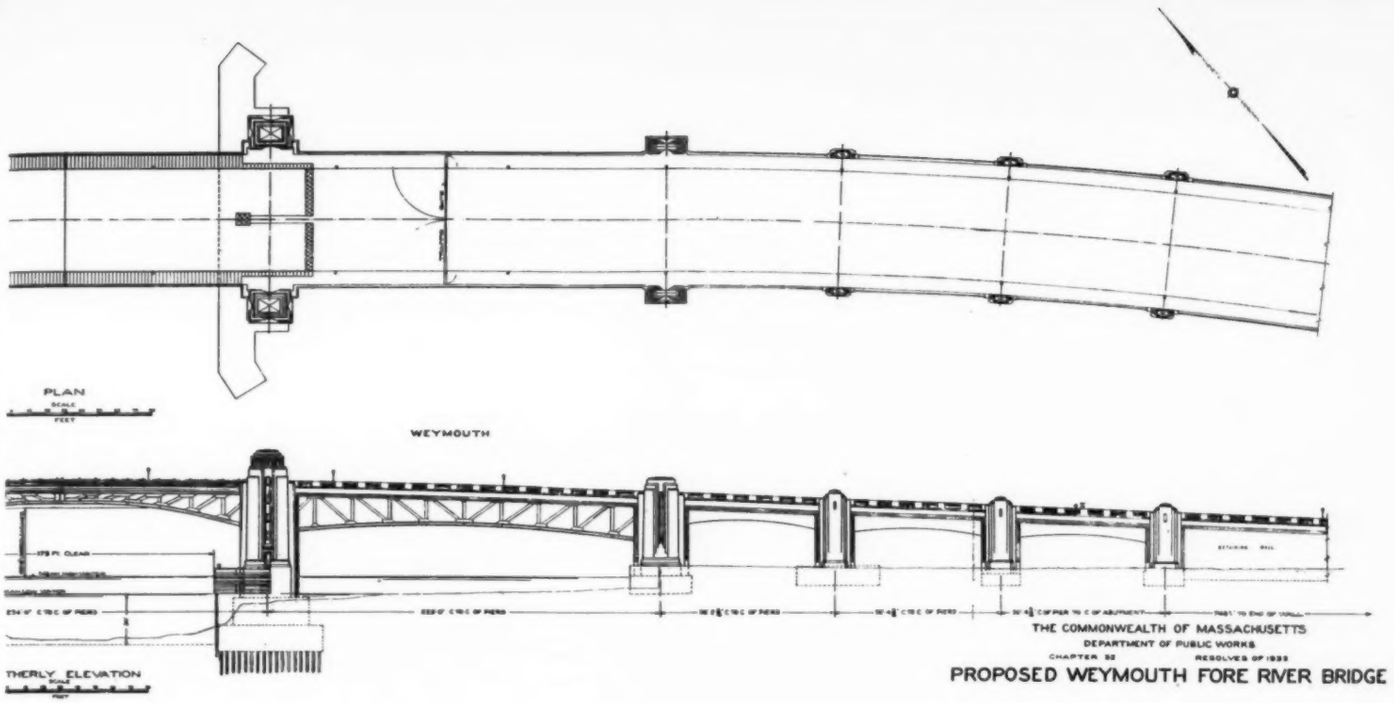
RECORDS OF BRIDGE OPENINGS

Year	Openings	Year	Openings	Year	Openings
1907	680	1915	1781	1923	2036
1908	657	1916	1387	1924	1353
1909	576	1917	1316	1925	1536
1910	825	1918	1483	1926	1174
1911	891	1919	1478	1927	2245
1912	570	1920	3208	1928	1998
1913	717	1921	939	1929	2324
1914	985	1922	715	1930	2235

Water Traffic Trebled in Twenty Years.—Of this traffic, a large percentage consists of tank steamers, oil barges, and their accompanying tugs bound to the Cities Service plant; and again outbound empty tankers, and loaded barges for harbor distribution, together with their tug boats. Occasional lumber schooners consigned to the Rhines Lumber Company and coal barges to the Sheppard Coal Company and the City Fuel Company required openings as did the larger ships to and from the Bethlehem Shipbuilding plant. From the records it will be noted that there will be a considerable increase in river traffic during the next twenty years as there is shore frontage available for further industrial development above the bridge.

Navy Department Interested.—The plant of the Bethlehem Shipbuilding Company is located above the bridge, and on account of its facilities for the construction and repair of shipping, particularly naval craft, the Navy Department is vitally interested in any changes in the bridge affecting the passage of vessels through the draw. The old channel opening was only 125 ft. and was too narrow for the largest war vessels, principally on account of a sharp bend immediately below the bridge which makes navigation difficult at this point. Both the United States Engineers and the Shipbuliding officials agreed that the new bridge should have a minimum channel of 175 ft. The United States Engineers further required a minimum clearance under the draw of 20 ft. at mean high tide. (It should be noted that the wider the draw opening permitting greater speed



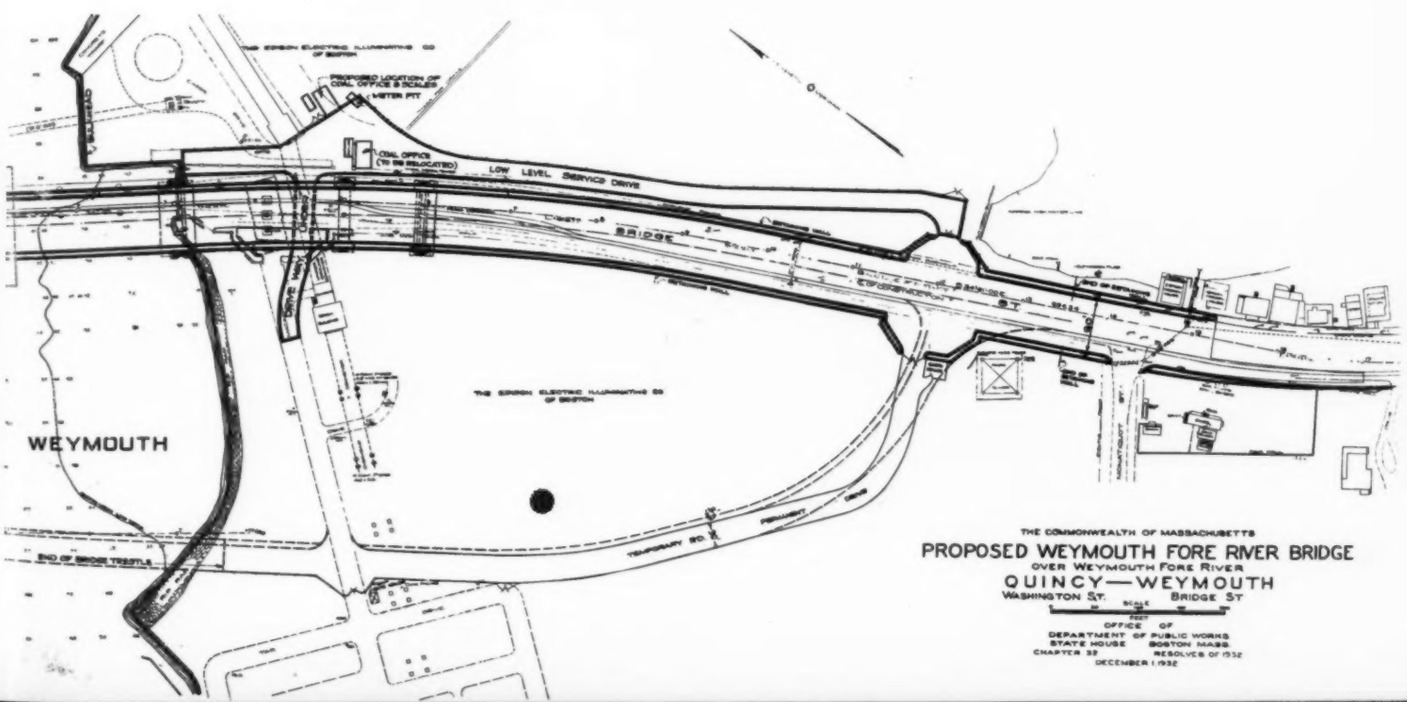


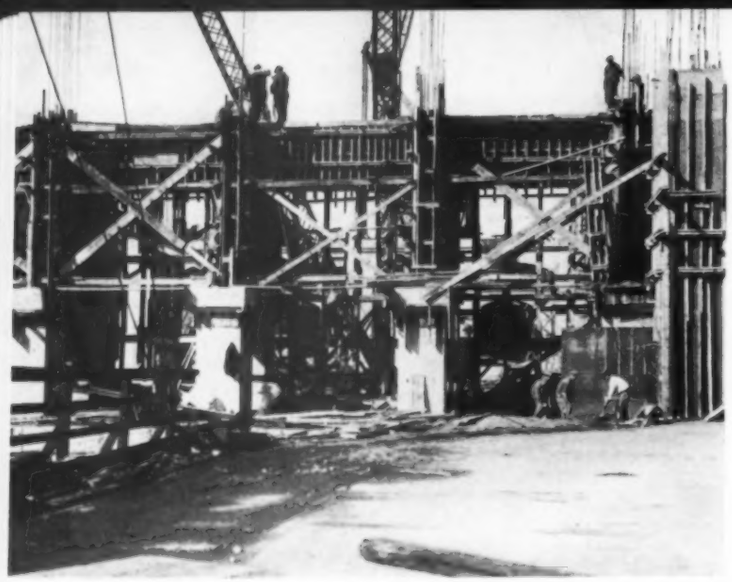
through the draw, the more materially reduced is the delay to highway traffic.)

The New Bridge.—The new bridge consists of a 60-ft. roadway and two 8-ft. sidewalks constructed at such a grade as to permit the passage of tugboats and small craft underneath the draw span without requiring any opening of the same. This width of roadway is necessary to take care of the 65,000 vehicles which will pass over the bridge per day before 1965. No provision has been made on the new bridge for the tracks of the Eastern Massachusetts Street Railway inasmuch as the street car company does not intend to operate street cars over the new bridge. The vertical headroom under the draw span when closed is 40 ft. above mean high water for a width of 100 ft. When the draw is open there is a clear width of waterway 175 ft. The foundations of the draw piers are sufficiently low to permit of a channel depth of 30 ft. at mean low water. This increased headroom, it is believed, will reduce the draw openings from about seven a day, lasting from 10 to 20 minutes each, to one opening of shorter duration due to a wider channel.

Changes in Grade and Line.—The center line of the new bridge is about 25 ft. south of and parallel to the center line of the old structure. The greatly increased elevation of the new bridge necessitated extensive changes in the approaches, which extend respectively from a point about 50 ft. east of Read Avenue, Quincy, and from a point about 250 ft. east of Monatiquot Street, Weymouth. The change in grade begins about opposite Dee Street, Quincy, from which the new approach rises on a 4 per cent grade to the Quincy pierhead line, thence by a vertical curve of 8,000 ft. radius over the river to the Weymouth shore, and descends on a 4 per cent grade to meet the present highway at a point about 100 ft. east of Monatiquot Street.

River Spans.—The section of bridge spanning the river consists of a draw span providing a 175-ft. clear width of opening with a 213-ft. fixed truss span on either side. Both fixed and draw spans are of the deck type. The draw span is of the double leaf rolling lift bascule type, and has been designed to open or close





in one and one-half minutes. The roadway gates are power operated and controlled from the draw-operator's room. The two large piers supporting the draw span are of concrete faced with granite. At each end of the piers are towers which rise above the level of the roadway masking the operating machinery. In the southwesterly tower, space is provided for the control room and for the transformers and other electrical equipment for the operation of the draw. The floor of the control room is some 10 ft. above the level of the road, and with windows on all sides the operator is afforded an unobstructed view of the highway as well as the river.

The Fixed Spans.—The fixed spans on both sides of the draw are supported at the shore line on massive concrete abutments faced with granite matching the facing of the bascule piers. Both abutments have towers which mark transition from the shorter and lighter construction of the shore spans to the longer and heavier construction of the river spans.

The Quincy Approach.—On the Quincy side, proceeding westerly from the pierhead line, the bridge consists of three 92-ft. spans. These spans are of steel deck girder construction with the outside girders faced with concrete. They are supported on concrete piers with ornamental towers or pylons which are faced with granite. The remainder of the Quincy approach consists of earth fill between concrete retaining walls. Due to the height of the approach, being some 26 ft. above the old highway level at Wharf Street and about 38 ft. at the pierhead line, it has been found necessary to provide service drives on both the north and south shore sides of the approach in order to afford access to the abutting property. The service drive on the northerly side extends to the Quincy shore line and on the southerly side as far as the property of the City Fuel Company. Provision has been made on the southerly service drive for a single track of the Eastern Massachusetts Street Railway which affords connection with its power house on Wharf Street. An underpass has been provided through the filled approach opposite Wharf Street of sufficient dimensions to care for street railway track, vehicular travel, and a steam railroad connection with the New York, New Haven and Hartford Railroad from the present tracks of the Fore River Ship Yard to property north of the bridge and bordering on Town River.

The Weymouth Approach.—On the Weymouth side, proceeding easterly from the shore line, the bridge consists of three spans of the same dimensions and of similar construction as on the Quincy side. The remainder of the approach consists of solid earth fill between concrete retaining walls. The new approach is about 36 ft. above the grade of Bridge Street opposite the present entrance to the property of the Edison Electric Illuminating Company, and a new entrance is provided about 800 ft. southerly where the grade of the new approach and the present highway meet From this point it is necessary to construct new driveways on land of the Edison Electric Illuminating Company on both the north and south sides of the highway to the coal plant and power plant respectively. A direct connection between these plants is possible beneath the first three spans just back of the shore line.

Below — Weymouth Station O+75 from Old Fender Pier, October 17, 1934

The Temporary Bridge.—To provide for highway travel during the two years in which it is required for the construction of the new bridge, a temporary structure having a 30-ft. roadway and 7-ft. sidewalk, was built. This temporary bridge is located about 400 ft. upstream from the present bridge. The approach on the Quincy side is through the yard of the Bethlehem

Shipbuilding Corporation, connecting with Washington Street near the corner of Dee Street. On the Weymouth side, the approach is over vacant land of the Edison Electric Illuminating Company and meets Bridge Street near the corner of Monatiquot Street. The locations of the approaches were discussed with the property owners and so placed as to cause as little inconvenience as possible with their operations.

Uses Old Draw.—The draw span of the old bridge is being used as the temporary draw. It was transferred on scows from the old location without dismantling. In designing the center or pivot pier for the temporary bridge, it was assumed that there was a possibility that the structure might be in use for several years. Working stresses comparable to those used in permanent structures were therefore used. Dead loads used were those of the existing draw span (weighing 600 tons) and the concrete cap of the pier.

Temporary Piling.—The pile group under the pier consists of 69 plumb piles and 32 batter piles. Of the 32 batter piles, 16 are set to resist rotary motion, eight are so set that their resistance is divided about half and half against rotary and lateral motion; and the remaining eight are set to resist lateral motion only. All batter piles are so placed that the concrete cap rests upon them as well as upon the plumb piles. All plumb piles have shoulders cut at the base of the cap to reduce punching shear as much as possible. When the draw is open the actual dead weight upon the plumb piles (allowing nothing for the batter piles) is approximately ten tons per pile. This is the figure used in the cap design. There is nothing allowed for live load or impact, as the ends of the span are supported when there is an appreciable live load on the span. Computations were also made for the twist of the entire pier due to the rotation of the draw span.

Uses Cable Bracing.—Due to the depth of the water at the location of the temporary bridge (26 ft. at low water) and the stability of location required for a pivot pier, it was considered desirable to brace the pier against swaying and rotation by some means in addition to the timber bracing usually used above low water. This was done by means of eight wire cables and turn buckles. These form tension braces from ground level to just under the cap. They should be good for several years.

Cost of Entire Project.—The estimated cost of the bridge is as follows:

Bridge and approaches	$1,715,000
Temporary bridge and approaches	118,500
Land takings and consequential damages	301,041
	$2,134,541

The Weymouth Fore River Bridge is being built by the Commonwealth of Massachusetts, Department of Public Works, William F. Callahan, Commissioner. The foundation is being erected under contract by V. Barletta Company, and the super structure by the McClintic-Marshall Company of Pittsburgh, Pennsylvania.

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LARGER ROAD EXPENDITURES RECOMMENDED FOR GREAT BRITAIN—The British Roads Improvement Association in its annual report for 1934-35, recommended that at least $50,000,000 per annum for the next 5 years should be made available for road development over and above the present scale of expenditure. It recommends that this sum should be devoted to new road construction of the major improvement character and additional traffic routes.

Highway Maintenance Equipment in Arkansas

Equipment used in the maintenance of Arkansas' state highways and the mileage of road maintained are listed in the last biennial report of the State Highway Commission as here shown.

For its various operations the Department controls and operates the major equipment as reflected by an inventory as of Oct. 1, 1934, summarized in the following tabulation together with its present estimated value.

	Type of Equipment	Money Value
182	Pull Type Road Graders	$ 53,077.72
218	One-Man Motor Patrol Graders	214,800.99
156	Crawler Type Tractors	139,202.66
34	Wheel Type Tractors	6,656.96
222	Items of miscellaneous equipment, Crushers, Rollers, Power Shovels, and Asphalt Equipment	131,631.48
163	Automobiles	50,944.67
78	½-Ton Pickups and Station Wagons	18,570.11
436	Trucks (1 ton to 5 tons)	123,761.68
356	Items of Shop Equipment	18,479.94
	Surveying Instruments and Equipment, Estimated	36,000.00
	Office Equipment and Supplies, Estimated	54,000.00
	Estimated Value October 1, 1934	$847,126.21

Surface Type	Complete Miles	Under Const. Miles
Concrete Pavement	1,017.01	19.73
Asphalt Pavement	538.21	29.35
Asphaltic Retread	451.84	3.72
Gravel	5,252.06	117.61
Graded and Drained	835.16	14.42
Unimproved	558.58	0.00
In Cities and Towns over 2,500 population	177.72	0.00
Total	8,830.58	184.83

Total complete and under construction—9,015.41 miles.

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Demonstration of High-Intensity Mercury-Vapor Street Lighting

Four new-type lighting units, incorporating G-E high-intensity mercury vapor lamps and representing a special lighting demonstration of the latest practical high-intensity street and highway luminaire, now illuminate the Lexington avenue side of the General Electric Building at 570 Lexington avenue, New York City.

Designed by General Electric engineers, the new luminaires will operate from an ordinary a-c series or multiple street-lighting circuit and are suitable for any type of high-intensity street lighting.

Two trial installations around the new post office at Lynn, Mass., and in Brooklyn's Albee Square have been sponsored by local civic groups and lighting companies. These units which resemble ordinary street lights in appearance, furnish light from a combination of mercury and incandescent lamps, with an efficiency stated to be approximately 50 per cent higher than that afforded by usual lighting installations.

Each luminaire includes a 400-watt high-pressure mercury-vapor lamp, mounted base down, and above it a 200-watt incandescent lamp and suitable reflector. The combined lamps have an output of 17,500 lumens, giving the unit an overall efficiency of about 29 lumens per watt.

The light from the mercury lamp itself is greenish-blue. Even so, a major part of the spectrum is included. When combined with the yellowish light from the incandescent unit, colors appear sufficiently natural for practical purposes—blue as blue, yellow as yellow, and red only slightly altered into brown.

The Orleans Street Viaduct, Baltimore

—Photos by courtesy of U. S. Bureau of Public Roads.

The views here shown are supplementary to the article on pages 163-166 of the May issue of ROADS AND STREETS. This 2,000 ft. viaduct, built chiefly on an existing street, will care for the heavy and rapidly growing volume of traffic between Baltimore and Philadelphia.

The pictures show as follows:

Upper Left: Where the approach was cut through.

Upper Right: The structure nearing completion.

Center Left: Looking along the street leading to Philadelphia.

Center Right: Steel of superstructure in place.

Lower Left: Arched girder spans and other construction.

Lower Right: View underneath, showing concrete piers and steel superstructure.

Fig. 1.—View of Caliche Road in New Mexico. (Courtesy New Mexico State Highway Department.)

ORIGIN AND ROAD BUILDING PROPERTIES OF CALICHE

By D. G. RUNNER

Assistant Materials Engineer, U. S. Bureau of Public Roads

IN the southwestern part of the United States, a material known as caliche is being used quite extensively in road construction. This material has been used over a period of years but due possibly to its restricted areas of deposition, has had little attention directed towards its possibilities in highway building. Some of the states in which caliche is found, notably New Mexico and Texas, have used this material for a number of years, and during this time have developed excellent methods of constructing durable, good-riding highways. Due partly to the lack of other road materials of suitable quality, and to the excessive cost of shipped-in aggregate, attention was of necessity focused upon the local deposits of caliche. Within the past few years, laboratory tests have been developed which have proven quite helpful in determining the suitability of caliche for various types of surfacing. This article has been written with the belief that information pertaining to the origin of caliche might be of interest to highway engineers. Numerous publications have been freely drawn upon for the necessary information relative to the subject, and these are listed in the bibliography.

In western South America, the name caliche is applied to the deposits of crude soda-niter, or what is commonly known as "Chile saltpeter." In North America, the term caliche is given to calcareous formations of varying thickness widely found in the semi-arid regions of Arizona, New Mexico, Texas and Oklahoma. The origin of the word caliche can be traced back to the Spanish word "caliche" which had particular reference to pebbles in clay bricks, or flakes of lime. Another derivation may be found in the Latin word "calx," meaning lime. Both of these derivatives are correctly applicable to deposits of caliche since these are nodular and chiefly calcareous.

The Origin and Composition of Caliche

Caliche is a material common to the semi-arid regions, and is essentially calcium carbonate in composition, although some caliches are comparatively high in silica. In addition these deposits are found at or slightly beneath the surface of the ground. Geologically they are said to be of comparatively recent origin, and form a "rock cover" throughout large areas of the southwestern states. According to Blake,[1] caliche is usually hidden from sight by a soil mantle, but is easily uncovered by digging, and is quite often discovered by a flow of water during heavy rainfall. The top portion of the caliche bed is sometimes more dense than the lower portion. The surface of this top portion is often smooth, though wavy, while the lower portions beneath the upper crust are earthy and porous, gradually blending into the sandy beds along which there is no sharply defined line of demarcation. The beds of caliche do not seem to form perfectly horizontal layers, but follow more or less the general undulations of the surface of the ground. These beds of caliche vary from a few inches up to 40 feet in thickness, sometimes outcropping at the surface of the ground, but more often hidden by the soil. The deposits cover many acres in various parts of Texas, Arizona, and New Mexico and often are exposed to view in artificial cuts. Breazeale and Smith[2] hold that

"all forms of caliche involve the solution, transportation, and precipitation of calcium carbonate. The formation of caliche is, therefore, largely a chemical phenomenon. The calcium carbonate may be dissolved and precipitated in the same stratum, as

[1]The Caliche of Southern Arizona, by W. P. Blake, Transactions American Institute of Mining Engineers, vol. 31, pp. 220, 1902.

[2]Caliche in Arizona, by J. F. Breazeale and H. V. Smith, Bulletin 131, University of Arizona, 1930.

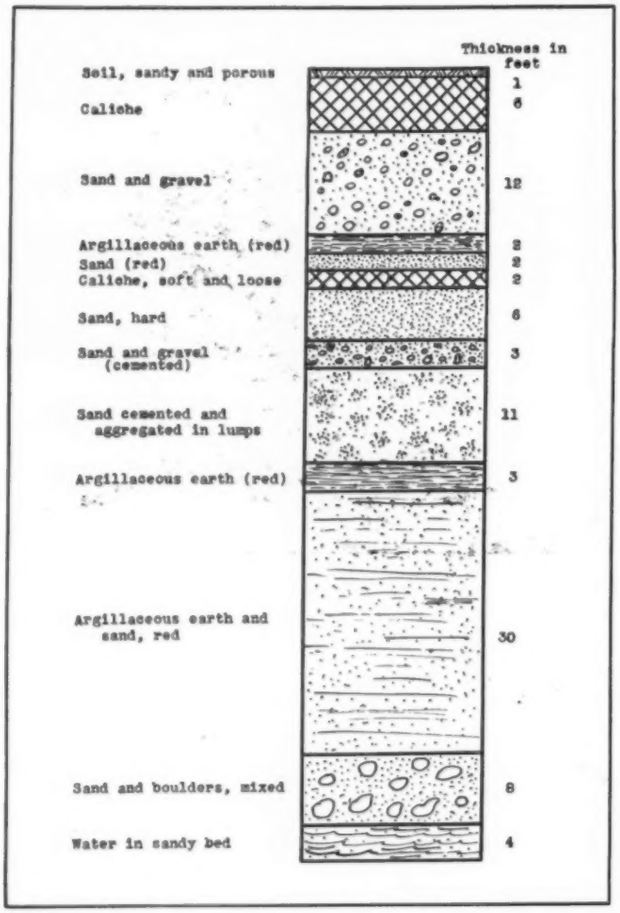


Fig. 2.—Typical Section Showing Beds of Caliche. Note Sand and Gravel Beneath Caliche. (After Blake.)

when a bed of caliche is broken up and recemented, or it may be transported in solution over long distances, and precipitated.

* * *

"The formation of caliche may be either a slow or a fairly rapid process; the density depends largely upon the rate of precipitation and the amount of foreign material in the mass. The dense, impermeable types which lie deep in the alluvial material filling valleys and basins are probably very old, while the softer types which lie near the surface in the flood plains, may be of recent origin.

* * *

"The position, structure, and chemical composition of the different forms of caliche indicate clearly that no one hypothesis can explain the origin of the different types."

The caliche of the southwestern United States is essentially a lime carbonate, containing in addition, magnesium, alumina and calcium silicates, and is in decided contrast with the true caliche of Chile. Analyses of two typical examples of caliche are given in Table I, in order to bring out the essential chemical differences. In the case of the Chilean caliche, only the principal constituents are given. The figures are of interest and point out the fact that the only similar characteristics between the two materials is to be found in the name "caliche."

It is believed that the origin of caliche is due to the upward flow of lime-bearing waters with subsequent evaporation at or near the surface of the ground, leaving the lime to be deposited and to cement the particles of sand and/or gravel. This condition of evaporation is somewhat intensified by the arid climate. In the southwest the unusual dryness of the atmosphere is accompanied by lack of rainfall, all of which induces rapid evaporation of the ground water. It is also believed that the limited rainfall penetrates only a short distance into the soil, but is sufficient to keep the ground water in the

TABLE I.—CHEMICAL ANALYSES OF CALICHE FROM SOUTH AMERICA AND SOUTHWESTERN UNITED STATES.

	A	B		C
$CaCO_3$	78.28	52.60	$NaNO_3$	53.50
$MgCO_3$	2.13	3.71	KNO_3	17.25
$CaSiO_3$	5.57	....	NaCL	21.28
$Al_2Si_2O_5$	7.37	....	Na_2SO_4	1.93
Fe_2O_3	1.88	....	$MgSO_4$	1.35
H_2O	1.20	....	$CaSO_4$	0.48
SiO_2	....	36.30		

A—Caliche from Arizona (Blake, *Trans.*, American Institute of Mining Engineers).
B—Caliche from Texas (Gillette, *Public Roads*, vol. 15, No. 10).
C—Caliche from Chile (Clarke, U.S.G.S. *Bulletin* 770).

TABLE II.—ANALYSES OF SPRING AND RIVER WATER IN THE SOUTHWESTERN UNITED STATES.

	A	B	C	D
CO_3	53.59	1.54	12.10	11.55
SO_4	3.40	43.73	16.07	30.10
Cl	1.35	22.56	29.78	21.65
Ca	30.95	13.43	8.03	13.73
Mg	3.45	3.62	2.52	3.03
Na	1.08	14.02	24.53	14.78
K	0.63	0.77	2.31	0.85
SiO_2	5.55	....	4.66	3.83

Note: All analyses from "Data of Geochemistry," F. W. Clarke, U.S.G.S. *Bulletin* 770.

A—Spring one mile west of Santa Fe, New Mexico.
B—Pecos River, New Mexico.
C—Gila River, Arizona.
D—Rio Grande River at Laredo, Texas.

shallow depths, thus producing the more dense upper stratum of caliche. Sometimes the deposits of caliche may consist of almost pure calcium carbonate, while other instances the minerals cement the sand and gravel particles into conglomerate-like beds. It is evident that the ground waters must have an abundant supply of lime. The source of this lime is to be found in the beds of limestone common to the caliche area; the soil; and the igneous rock formation.

Calcium carbonate is almost insoluble in pure water, but dissolves comparatively easy in water containing carbon dioxide. The percentage of carbon dioxide in certain ground waters is fairly high, and held in solution by pressure. Water of this character has a decided solvent action on limestone, in which case the calcium carbonate and magnesium carbonate are dissolved. The precipitation of the calcium carbonate is probably caused by the evaporation of the water, or by the loss of the carbon dioxide. The reaction typical of the precipitation of calcium carbonate is shown below:

calcium bicarbonate	=	calcium carbonate	+	water	+	carbon dioxide
$Ca(HCO_3)_2$		$CaCO_3$		H_2O		CO_2

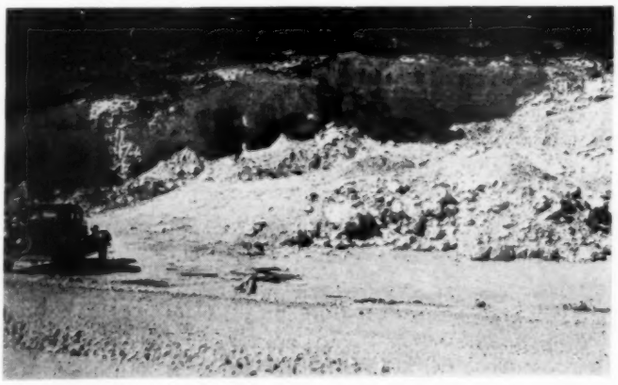
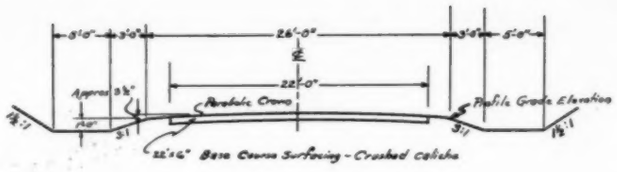


Fig. 3.—View of Hard Caliche Pit Showing Strata Formations. (Courtesy Texas State Highway Department.)



Typical Section

Fig. 4.—Typical Cross-Section for Caliche Base Course Surfacing. (Courtesy New Mexico State Highway Department.)

It is the opinion of several investigators that a combination of high water table, underground water, rapid evaporation, and other features are the chief factors in the formation of caliche. In order to show that spring and river waters contain the minerals necessary for the formation of caliche, the analyses in Table II are given. It will be noted that the spring water shows a higher calcium carbonate content than the river waters. This condition is probably due to the ability of the water in springs to become more saturated from lack of movement. Spring waters receive rain or ground water and blend with water from other sources to form the larger streams. A river is merely the waters of all its tributaries plus rain and ground water, and consequently its composition is likely to be more variable.

The chemical work of ground water is chiefly confined to that zone extending from the water table downward. The chief chemical processes are solution with attendant redeposition, carbonation and oxidation. Limestone beds are actively dissolved by this ground water, and the rate of solution is a function of the temperature of the solvent. In any event the solution is continued until saturation is reached. It is known that no mineral is entirely unaffected by ground water solvents, even quartz is slowly acted upon. As stated above, redeposition, or cementation, accompanies solution, so that by capillarity the dissolved minerals are carried upwards to be deposited. The ultimate result of this procedure is the lithification, or hardening, of the upper crust. In contrast to the ascending waters carrying the dissolved minerals, the descending waters may also deposit calcium carbonate from the carbonated rain water. Figure 2 illustrates a typical caliche section showing the sand-gravel beds beneath the caliche.

It should be understood that in a paper of this length, no complete discussion of the origin of caliche can be attempted. In case further information is desired the references at the end of this paper should be consulted. However, it is thought that enough descriptive matter has been included to enable the engineer to understand something of the origin and composition of this most peculiar type of material.

Types of Caliche

Caliche as found in the southwest can be classified into three general groups; the soft, the medium hard, and the hard. The soft type of caliche is sometimes found near the surface of the ground which lends belief that it is of recent origin. It is earthy, loosely cemented, and very porous, and usually blends into the sandy or gravelly beds beneath. This soft earthy variety of caliche is white in color, but quite often has a brownish, pinkish or grayish tinge which is probably caused in part by the mineral composition. In connection with its excavation, this can usually be done without any mechanical means, and may be loaded into trucks or elevating machines, with hand shovels. The Semi-hard type of caliche is a mixture of the hard and soft types, and as the name implies, intermediate in hardness. It is reported that all degrees of hardness may be found in the same deposit. This variation may be accounted for in part by the variations in the rate of precipitation and evaporation, and in the amount and kind of foreign matter in the deposit. In some formations, especially in Texas, it is reported that one deposit of semi-hard caliche approached a maximum thickness of 25 ft. In handling this type of material for road use, it has been found necessary to employ rooters to loosen the material to a satisfactory stage or condition. The hard caliche, of course, refers to the dense, impervious firmly cemented type, and is probably of much older origin than either the soft or semi-hard types. Sometimes beds of hard caliche are formed of well-stratified layers and/or deposits of pebble-like material firmly cemented by the calcium carbonate. Caliche of this character usually requires the use of dynamite to break the material into suitable sizes for handling. Figure 3 is a view of a caliche pit of the hard type. The hard caliche when combined with the soft flour-like type is excellent for use in highway construction.

Caliche in Road Building

Caliche has been used for a number of years as a road-building material, both in base course and in surface course cosntruction. As far back as 1925,[3] caliche was used for surfacing purposes with apparently good results in the state of New Mexico. Because of the fact that certain areas of the southwest contained no other materials of suitable quality for surfacing purposes, it was found necessary to use the only available material. Caliche possesses the property of hardening when wet, which feature is commonly utilized in constructing pavements of this material. However, the scarcity of water in the arid sections made it necessary to obtain the desired compaction by other methods. It was found that crushing the caliche to smaller sizes aided somewhat in the dry compaction, and that the finer the material was crushed, the greater the ease of compacting when in a dry state.[4] This condition is usually obtained by the use of grading machines, and by the action of traffic.

Usually the specifications for a caliche base require the material to be put down in two courses, the first course to be thoroughly wet and compacted before the second course is begun. The loose material laid at least nine inches in depth, compacted to a thickness of four and a half inches. The caliche, after wetting and rolling, is allowed to "set-up" before the second course is placed. Before putting on the top course, the base section is bladed even and brought to grade. The top course procedure is essentially the same as that employed in constructing the bottom course. Figure 4 shows a typical

[3]Caliche and Other Native Road Materials, by W. C. Davidson, New Mexico Highway Journal, July, 1925.
[4]Caliche as a Surfacing Material for Highways, by W. C. Davidson, The Highway Magazine, vol. 18, April, 1927.

Fig. 5.—Crushing Plant in Operation. (Courtesy New Mexico State Highway Department.)

section for caliche base course surfacing in New Mexico. This section calls for a 22-foot roadway with the surface having a parabolic crown. Figure 5 illustrates the quarrying and crushing operation at a caliche pit in New Mexico.

In Texas one favorite method of construction in which caliche is used is a two-course base topped with some type of bituminous treatment.[5] These bituminous treatments are designated as single, double, or triple on caliche. In some instances the caliche base courses are topped with Uvalde rock asphalt.

In order to show how caliche is utilized in road construction excerpts from the specifications of two state highway departments, which use this type of material, are given. The following specification is taken from the New Mexico standard specification for "Crushed Selected Material Surface Course."[6]

DESCRIPTION

This item shall consist of a wearing course composed of crushed rock, caliche or gravel placed in one course, and shall be constructed on the prepared sub-grade in accordance with these Specifications and in conformity with the lines, grades, dimensions and typical cross section shown on the Plans.

MATERIALS

The crushed rock, caliche or gravel shall contain or be mixed with binder material, suitable in the opinion of the Engineer, so as to conform to the following grading requirements, and when tested by laboratory methods the material including binder shall meet the following requirements by weight:

Material passing through screen with 1 inch circular openings 100%
Material passing through ¼ inch screen.....35 to 50%

The Engineer may vary the requirements within the above limits to obtain satisfactory results.

The stone from which the material is crushed when tested by the abrasion tests, using round pebbles, shall show a per cent of wear of not more than 25, and when using broken fragments shall show a per cent of wear of not more than 15. The cementing value of the binder shall be not less than 100.

The Contractor shall provide a screen or other suitable means to eliminate fines below the No. 10 mesh if such fines should prove to be objectionable materials. The wasted material shall be disposed of as directed by the Engineer.

Oversize stones shall not be wasted except as hereinafter mentioned, but shall be crushed to such sizes as make it conform to the above requirements. The crushed oversize material shall be returned to the screen and remixed with the other materials so that the product will be uniform. The Engineer may permit the wasting of boulders which require breaking before going to the crusher.

CONSTRUCTION METHODS

If surfacing is to be placed on a previously graded road, the existing roadbed shall be brought to a uniform line and grade as directed by the Engineer.

After the sub-grade has been brought to the alignment, grades and cross-sections as directed by the Engineer, it shall be trenched, where plans calls for trenching, to conform to the cross-sections shown on plans. The width of the trench shall be as shown on the plans and cross-section.

Rolling of section prior to placing surfacing will not be required, but the Contractor shall be required to keep the sub-grade dressed immediately ahead of surfacing to eliminate ruts and bumps left by the surfacing trucks or wagons. All soft or otherwise unsuitable materials shall be replaced with materials satisfactory with the Engineer.

(a) *Depositing and spreading.*—All surfacing shall be spread to a uniform thickness to conform approximately with cross-section as shown on plans. Sufficient force shall be employed to promptly and properly handle the surfacing material as soon as it is delivered on the road in order to secure a regular and uniform thickness and depth.

If the Contractor elects to haul over the surfacing any irregularities which may develop in the surfacing shall be remedied by the Contractor at his own expense.

(b) *Blading.*—After the surfacing material has been placed to a uniform thickness the whole amount of surfacing material shall be moved to one side of the road by a blade with not less than fourteen (14) foot wheel base and placed in a windrow. The material shall then be bladed to a windrow on the opposite side of the road after which it shall be spread to cross-section shown on the plans. The Contractor shall continue his blading operation in such a manner that not more than one (1) mile of surfacing material shall be in place at one time without being under blading operation.

(c) *Shaping.*—When the surfacing has been deposited and bladed as provided above, the entire roadway shall be shaped with a blade from shoulder to the crown shown on the plans.

(d) *Finishing.*—The surfacing deposited each day shall be bladed and dragged at the end of the day's run and all surfacing placed shall be bladed and dragged throughout its entire distance every other day or more often if necessary in the opinion of the Engineer to maintain it true to crown, grade and surface to which it is constructed. These operations shall continue until all work on the contract has been completed.

Fig. 6.—View of Caliche Base Course Before Processing. (Courtesy New Mexico State Highway Department.)

Figure 6 shows the condition of a caliche base before processing, in New Mexico.

The following specification for caliche base course illustrates how the State Highway Department of Texas utilizes caliche in road construction:[7]

MODIFIED CALICHE BASE COURSE

Description.—This item shall consist of a foundation course for surface courses or other base courses, shall be composed of caliche, and shall be constructed on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades, compacted thickness, number of component courses and typical cross section shown on the plans.

Material.—Caliche shall consist in general of calcareous dust with or without sand, small stones, gravel or limestone, all of which when tested shall pass a 2 inch screen, shall not contain more than 5% of free clay (i.e., clay not naturally intimately mixed with the caliche), and shall be free of dirt. The cementing value shall be not less than 75. All the material shall be screened and portions not passing a 2 inch screen shall be so crushed that when tested by laboratory methods it will pass a 2 inch screen. After the crushing and screening of the material as above outlined, the screened and crushed portions shall be mixed so that a uniform mixture of screened and crushed material will be obtained. Any material taken from pits rejected as unsuitable by the Engineer shall be paid for as stripping.

Construction Methods.—First course: Side forms of wood (or steel) of proper size shall be used as indicated on plans, and set accurately to grade and alignment according to Engineer's stakes. Side forms, if of wood, shall be not less than the thickness of 3" commercial lumber, and of sufficient depth to retain the loose material in each course.

Immediately before placing the caliche, side forms shall be tested and reset to true grade and line. The subgrade shall be tested to insure conformity with the established lines and grades and the typical cross-sections shown on the plans. The material shall be delivered in vehicles of uniform capacity and spread uniformly upon the prepared subgrade to such depth that when compacted the thickness shown on typical cross-section will be secured. It shall be the charge of the Contractor that the required amount of material shall be delivered in each 100-foot station. Caliche deposited upon the subgrade shall be spread and shaped within 24 hours. In the event inclement weather or other unforeseen circumstances render impractical the spreading of the caliche during the first 24-hour period, the caliche shall be scari-

[5]Caliche Base and Triple Bituminous Top, The Earth Mover, vol. 20, No. 2, February, 1933.

[6]Supplied through the courtesy of the New Mexico State Highway Department.

[7]Supplied through the courtesy of the Texas State Highway Department.

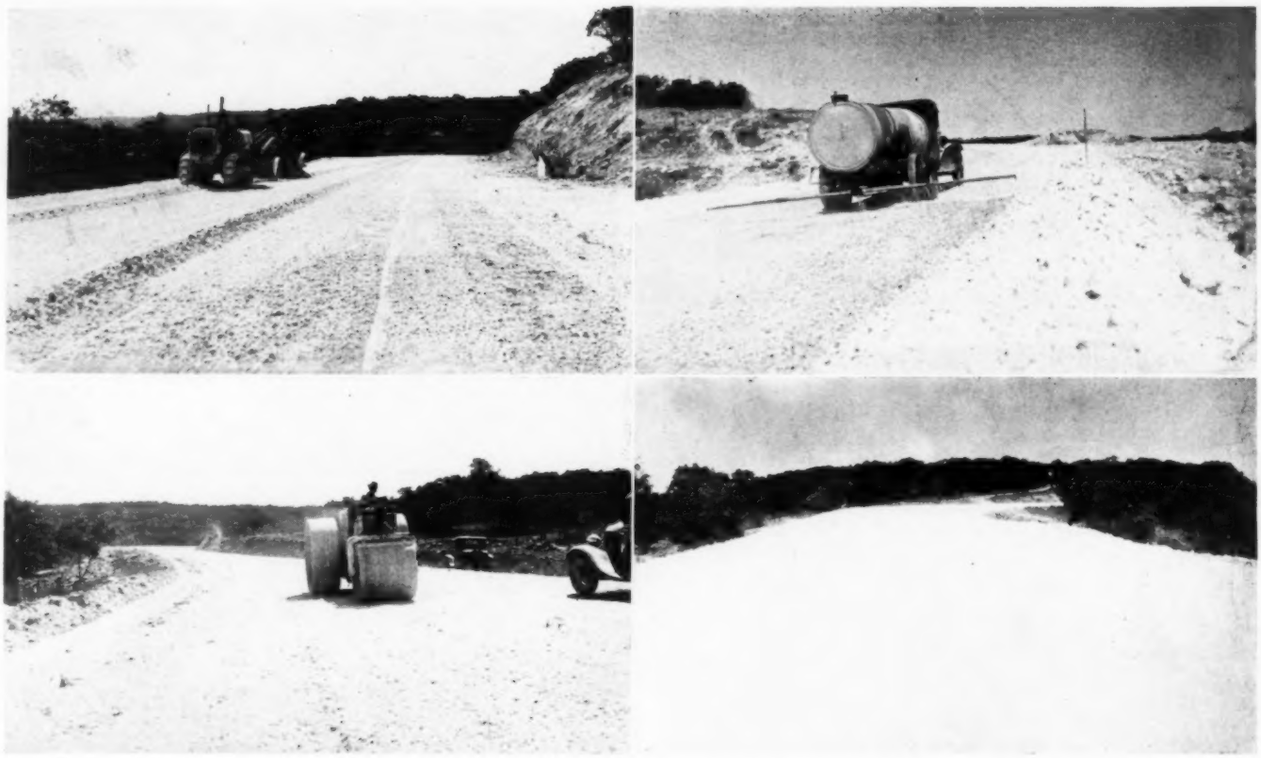


Fig. 7.—Constructing a Caliche Road in Kendall County, Texas. Upper Left: Processing Base Course. Upper Right: Wetting Base Course Prior to Rolling. Lower Left: Rolling Base Course. Lower Right: Completed Road. (Courtesy Texas State Highway Department.)

fied and spread as directed by the Engineer. The dry caliche shall be dressed and shaped to conform to typical cross-section as shown on plans. The course shall then be sprinkled to the extent directed by the Engineer. All irregularities caused by the sprinkling operation shall be corrected immediately. The course shall then be rolled as provided under Item 31—Modified, "Extra Rolling and Sprinkling Subgrade and Base Courses," to the extent directed by the Engineer.

A straight edge frame 18 feet long shall be placed parallel to center-line of road so as to show any irregularities or undulations. A templet conforming to the typical cross-section shall be placed at right angles to the center-line of road so as to show any irregularities or undulations. All irregularities or undulations shall be remedied by loosening, adding, or removing material and rerolling. The utilization of traffic to compact and bind the base course or courses is an essential part of the contract and is of prime importance to the satisfactory completion of the work. As directed by the Engineer the completed course or courses shall be opened to traffic. It shall be the responsibility of the Contractor to direct and distribute the traffic uniformly over the entire width of the course, and the surface of the course shall be maintained by the continuous use of a sufficient number of satisfactory brooms, blading, patching, sprinkling and rolling. Raveled sections shall be repaired by loosening and rebinding. These operations shall continue until, in the opinion of the Engineer, the base course is sufficiently compacted and bound to permit the application of the next course. Side forms shall be removed when directed by the Engineer.

Second Course: Construction methods shall be the same as prescribed for the first base course.

Figure 7 illustrates the construction of the caliche surface in the State of Texas.

Tests to Determine the Quality of Caliche

It has been known for some time that there is a wide difference in the quality of caliche. This variation is probably due, in a measure, to the character of the material in which the development of the caliche took place. In other words, differences in the type of sand and/or gravel may possibly have influenced the ultimate formation of the caliche beds. In addition, it is possible that the amount and kind of minerals in the ground waters might have had an appreciable effect upon the final development of the caliche. Some deposits contain high percentages of silica in addition to the calcium carbonate, and it is possible that this feature caused some variation in the quality of the material. Chemical analyses will show, of course, this feature.

During the past years, the tests commonly employed to determine the quality of caliche for surfacing purposes have been: chemical analysis, cementing value and slaking. However, during recent years, tests employed in sub-grade soil analyses have been applied to aid in determining the quality of caliche. In brief these tests are: shrinkage limit, liquid limit, plasticity index, shrinkage ratio, field moisture equivalent, etc. The limit of space prohibits fuller discussion of these tests and their applicability. However, they are fully presented in the December, 1934, issue of Public Roads, in an excellent article by H. S. Gillette, entitled "Soil Tests Useful in Determining Quality of Caliche." The following summary regarding the uses of caliche are taken from this article:

1. "The suitability of caliche base courses for bituminous surfacing depends upon the quality and quantity of the fine binder material (passing the No. 40 sieve) contained in the total volume of material in place.

2. "The quality of the binder depends on the geologic origin of the material. The quality can be determined by the standard physical soil tests developed by the Bureau of Public Roads. Study of soil constants derived by subjecting caliches which have given various degrees of road service to this standard series of tests makes possible the establishing of suitable limiting test values.

"The quantity of fine soil binder (material passing No. 40 sieve) depends on the nature of the caliche deposit and on the mechanical appliances and methods used in excavating and handling.

3. "The hard and semihard caliches are the best materials since they are most likely to contain a desirable quantity and quality of fine binder material.

4. "Flourlike or very fine caliches may be used under favorable conditions. However, they generally contain an excessive amount of very fine clay and colloidal material. Such fine ma-

terial will bind and set when properly manipulated, but the completed road has very high capillary action. Material of this kind should be thoroughly investigated before being used.

5. "In regions of sparse rainfall, freedom from frost or snow, and good surface drainage, caliches with high colloidal content, as evidenced by high liquid limits, high plasticity indexes and colloidal gels, may be successfully used to carry light traffic without surface covering. This type of caliche will prove most unsatisfactory if a surface covering, which prevents evaporation of capillary moisture, is placed on top or if it is placed without providing good drainage.

6. "The minimum depth of compacted base course that will give good service, as deduced from records of roads that have been built for 5 or more years, is 8 inches.

7. "Base courses in excess of 4 inches compacted depth will give better service if built in two courses. The base course material should be thoroughly compacted from the subgrade upward."

Indications point to the fact that caliche-surfaced highways have been giving favorable service for a number of years. These highways were constructed using simple laboratory tests such as cementing value, slaking, etc. With the newer and more informative tests developed by the Bureau of Public Roads for determining the quality of caliche, there is the possibility that even better and more durable highways can be constructed using this type of material.

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Indiana Extends Soils Testing

The Indiana State Highway Department is entering its second season of stabilization work with plans for extending the activities of the soils organization. At present the organization consists of an assistant district engineer in charge of tests and materials in each of the six districts in the state, four soils engineers working specifically on stabilization tests in the soils laboratory, and a force of 10 field men. The department is under the direction of Mr. Arthur R. Smith, engineer of tests, who also has charge of the general laboratories of the highway department.

Established in March, 1934, the soils laboratory has

Interior of the Indiana State Highway Department Soils Laboratory Showing Liquid Limit Machine, Burette, and Other Equipment Used in Determining Plasticity of Soils

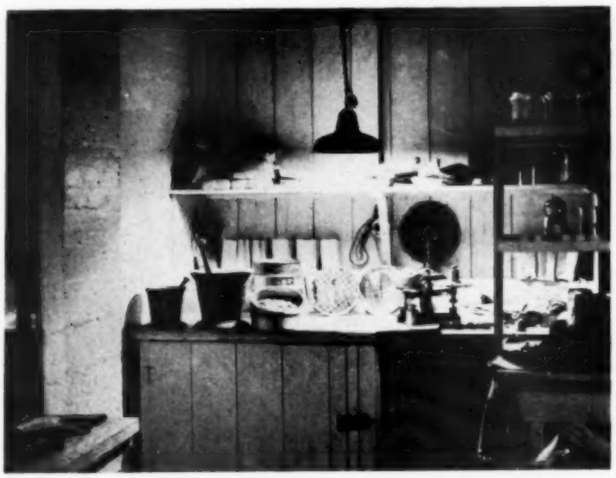
run tests on more than 200 miles of road, and up to May 15 this year had supplied 1,230 complete soils analyses. Of the 200 miles of roads tested, about 160 miles were given stabilized surfaces, and the remaining mileage was tested for stabilized subgrade construction.

In addition to making the soils tests to determine stabilized mixes, the soils organization checks subgrade and drainage conditions and makes recommendations to the treatment of fills and cuts. Whenever possible, soils surveys are made at the same time that location surveys are run. Mr. Smith predicts that an increased organization will be required this year, as the work of the department is extended to more and more subgrade construction.

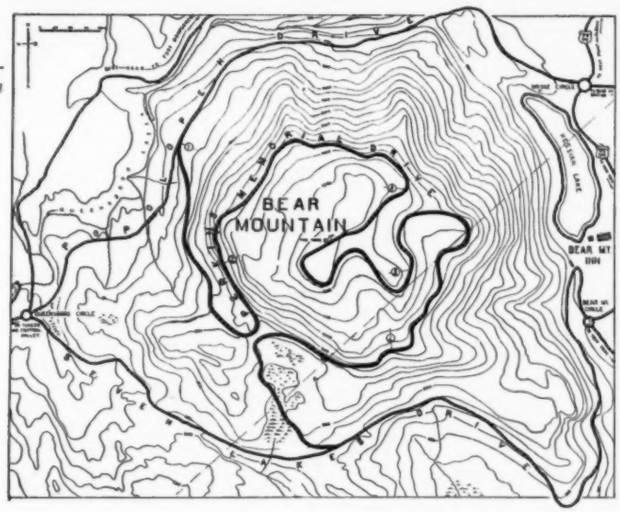
Commenting on the stabilization method of construction, using binder soils and hygroscopic chemicals following recommendations of the U. S. Bureau of Public Roads, Mr. Smith says:

"We are convinced as a department of the value of a chemical in the treatment of clay and aggregates to obtain a maximum density in stabilization as a method of construction for either subgrade base course or surface."

One of the pioneer states in the extensive use of the stabilization method, Indiana constructed 160 miles of stabilized roads on the state highway system in 1934.



Interior of Indiana State Highway Department Soils Laboratory Showing Sieves and Scales Used in Determining Gradations and Proportions



Location of Perkins Memorial Drive and Its Relation to Other Drives

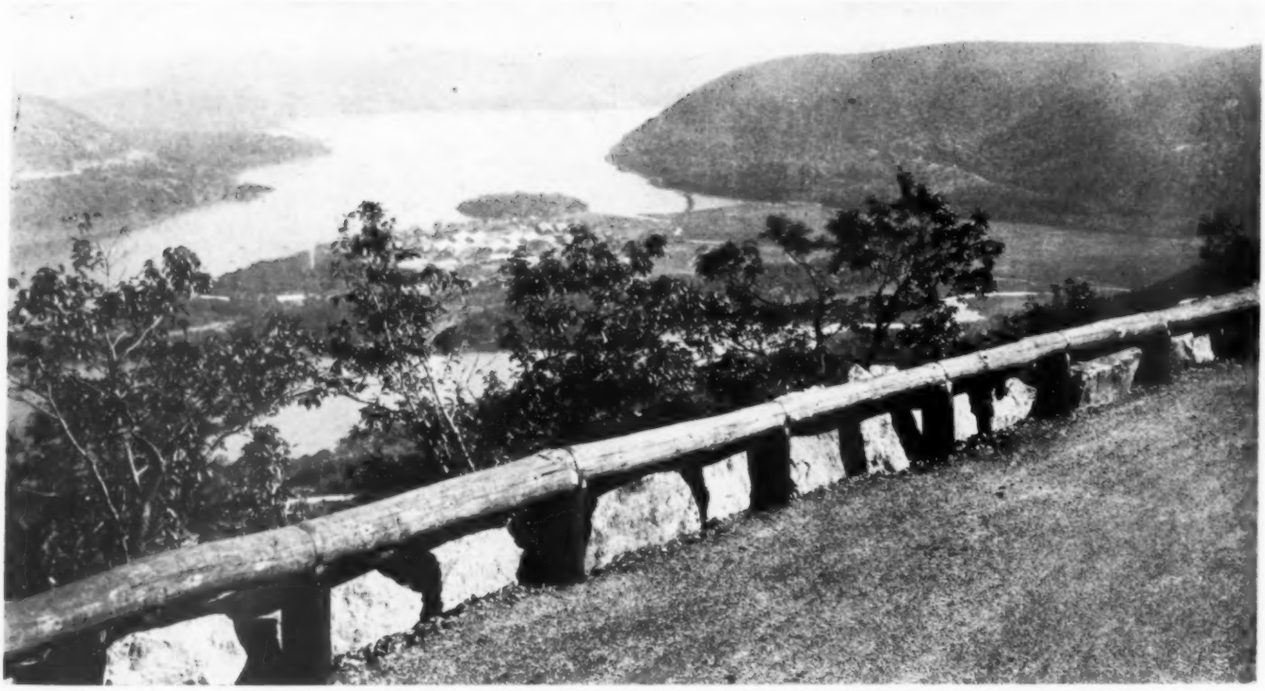
THE PERKINS MEMORIAL DRIVE
A 5-Mile, $1,357,000 Work Relief Project

By A. B. GREENLEAF
Field Editor, Roads and Streets

THE Perkins Memorial Drive in Bear Mountain Park, New York, recently completed, undoubtedly, will become famous as one of the great scenic drives in Eastern United States. This drive, five miles in length over Bear Mountain, was dedicated to the first president of the New York Commissioners of the Palisades Interstate Park, the late George W. Perkins, who was chiefly responsible for the project. This scentic route may be reached by traversing either the Popolopen Drive or the Seven Lake Drive which connect with Route U. S. 6. Both these feeder drives are constructed or improved at about the time the Perkins Memorial Drive was worked on. The Perkins drive was built over a period of 23 months as a work relief project of the New York State Temporary Emergency Relief Administration at a cost of $1,357,959.48.

Designed by Major W. A. Welsh.—The drive affords the motoring public new and magnificent views of the grandest parts of the highlands of the Hudson and the Hudson River gorge. Funds for the completion of the drive were supplied through State and Federal allocations to the Temporary Emergency Relief Adminis-

George W. Perkins Memorial Drive; Looking West South Side of Bear Mountain



George W. Perkins Memorial Drive: Looking South, Southeast Side of Bear Mountain

tration. The drive is the most important single project undertaken during the past two years in the great program of construction in the Palisades Interstate Park with Temporary Emergency Relief Administration support. This program has been a very valuable contribution toward providing work relief for heads of families in Greater New York, Yonkers and Rockland and Orange counties. Out of the several thousands of men assigned to work relief in the Palisades Interstate Park by the Temporary Emergency Relief Administration, from 600 to 760 men have been assigned daily to work on the drive. Inasmuch as one of the purposes for building the drive was to make work for the unemployed, 90 per cent of the work on the drive was performed by hand. The drive and tower were designed by Major W. A. Welsh, General Manager and Chief Engineer of the Palisades Interstate Park who was a friend and valued associate of George W. Perkins. The work has been under the field direction of Mr. John J. Tamsen, Superintendent of the New York Divisions of the Palisades Interstate Park.

Widening Approach Road from 15 Ft. to 30 Ft.

Top: Rock Drilling for Blasting for Road Widening; Ingersoll-Rand Compressor. Bottom: Removing Rock and Dirt After Blasting. Rock Is Loaded with One Truck and Dirt with the Other

Pays Transportation Charges.—The Perkins Memorial Drive was begun on Nov. 21, 1932, under the direction of Mr. Harry L. Hopkins, Federal Relief Administrator. The Administration in its search to find wholesome outdoor work for New York City men on projects that would have both the elements of public use and permanence, was prepared to send men to Palisades Interstate Park provided that the problem of transporting thousands of men daily from New York City 41 miles up the Hudson to Bear Mountain could be solved. Generous co-operation of the New York Central Railroad Company provided the solution by putting into service on its West Shore Division from the West 42nd Street Ferry and Weehawken, special trains at the round-trip fare of 50 ct. which amount was added to the daily wage of $4 by the Temporary Emergency Relief Administration so that the cost of transportation was not borne by the workers. From the railroad station at Bear Mountain to the Perkins Memorial Drive, the workmen were transported by busses also at the expense of the T.E.R.A.

Worked in Two Groups.—Under the direction of the New York State Temporary Emergency Relief Administration 760 men were assigned to work on the drive in two groups, each group working two weeks a month. This arrangement continued until Dec. 2, 1933, when

the project was transferred to the Federal Civil Works Administration. 764 men then worked daily, each man working thirty hours per week from Dec. 4, 1932, to March 31, 1934. The project then was returned to the direction of the New York State Temporary Emergency Relief Administration and, until the completion of the job, the men have been working in two groups, 600 men to the group, each man working 24 hours weekly.

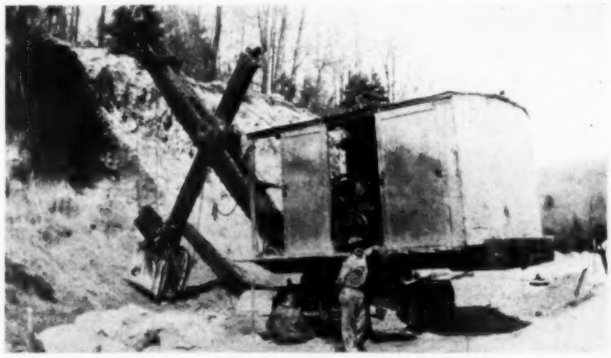
What the Work Included.—Figures compiled by Mr. Tamsen give an idea of the magnitude of the job and the amount and variety of the hand work. The length of the drive from Seven Lakes Drive on the south side of Bear Mountain following numerous curves and loops over the top of the mountain to Popolopen Drive on the north is 25,600 lin. ft., or nearly five miles. The road is 28 ft. wide and the surface area including both rough and finished grading is 79,644 sq. yd. Rock excavations totalled 155,000 cu. yd., earth excavation 20,000 cu. yd., rock and earth fill 175,000 cu. yd. The total of hand drilling was 151,299 ft., of machine drilling 206,625 ft., total drilling 357,924 ft. Dynamite used was 90,970 lb. with 113,079 blasting caps.

In the surfacing of the highway, there were used 8,850 cu. yd. of ¾ to 1½ in. broken stone, hauled, spread, graded and rolled; 1,121 cu. yd. of ⅝ in. chips; and 130,000 gal. of road binder, hauled and applied with park equipment.

Guard Rail Construction.—Stones, obtained from blasting on this and other projects and placed as a parapet 3 ft. high, cover 25,275 lin. ft. Where the outside bank is steep, there have, in addition to the parapet stone, been placed 1,950 lin. ft. of guard rails made of natural chestnut salvaged from blight-killed trees in the park. The combination of parapet stone and chestnut guard rails give to visitors a complete sense of confidence and safety.

Architecturally Landscaped.—One of the last steps in completing the drive was to smooth out places left raw by blasting and earth excavation with the use of 453,530 sq. ft. of sod. This was not lawn sod, but wild, natural, old field sod, full of all sorts of native wild flowers, asters, golden rods, daisies and others, and cut a foot deep so that when placed along the shoulders and sides of the drive, it took root at once, and, even before the drive was finished, had started to grow and bloom, making the road look as if it had been there for years. In order to cover some of the higher inside

Widening Approach Road from 15 Ft. to 30 Ft.



Top: Osgood Shovel Removing Boulder and Dirt for Extension of Road Width. Bottom: Universal Truck Crane Pulling Boulders from Underneath Pavement to Make Place for Culvert.

faces of blasted stone, conspicuous while the work progressed, use was made by Major Welsh and Superintendent Tamsen of various types of greenery. Inner cuts were slanted at an angle to hold dirt and earth pockets and irregularities were made in the cuts into which loam and humas were set, for planting native trees and vines. Then the whole area was sodded over. Higher outside banks and fills were given similar treatment, large holes being left for trees and shrubs and uneven surfaces provided to hold a final covering of earth and native sod. Much of this sod was obtained, without cost, from the New York Trap Rock Corpora-

Widening Popolopen Drive (a connection with the Perkins Drive) from 15 Ft. to 30 Ft.

tion's limestone quarry at Tomkins Cove, three miles away.

Native American Stock Plantings.—Native flowering shrubs such as mountain laurel, azalea, hardhack, sweet pepperbrush, meadowsweet, and others, salvaged in the construction of new lakes and other operations throughout the park by members of the dozen Civilian Conservation Corps camps stationed therein, were planted on the sod, so that by spring, the banks of the entire drive will blossom with wild bloom. Not an exotic species was used; all the planting is of native American stock.

Views from the upper part of the drive to the south, east, north and west are increasingly superb as the drive climbs around the mountain and higher levels are reached. On a clear day, there is visible for a radius of 75 miles, a complete circuit of the horizon including the skyscrapers of New York City, Westchester and Putnam County Hills, Berkshires, Taconics, Shewangunks and Catskills, and, across the 50,000 acres of the Highlands of the Hudson embraced in the park, High Point in northwestern New Jersey with its war memorial tower on the highest summit of the Kittatinny Mountain.

Quantities and Cost.—The following tabulation gives statistics of work done by relief labor on Perkins Memorial Drive:

Length of roadway	25,600 lin. ft.
Width of roadway (exclusive of parking spaces)	28 ft.
Surface area of roadway completed (rough and finished grades)	79,644 sq. yds.
Telford, sub-base, all hand laid	30,118 cu. yds.
Rock excavations	155,000 cu. yds.
Earth excavation	20,000 cu. yds.
Fills, rock and earth	175,000 cu. yds.
Rock, hand drilling (measurements taken from each hole)	151,299 ft.
Rock machine drilling (measurements per hole)	206,625 ft.
Grand total of rock drilling (hand and compressor)	357,924 ft.
Dynamite used	90,970 lbs.
Blasting caps (electric exploders) used	113,079
Macadamizing roadway—	
Specification stone (¾ in. to 1½ in.) hauled, spread, graded and rolled	8,850 cu. yds.
Stone, ⅝-in. chips, hauled, spread, graded and rolled	1,212 cu. yds.
Road binder used (hauled and applied with park equipment)	140,000 gals.
Guard rails constructed (native chestnut), 32 ins. high	44,000 lin. ft.
Parapet stone, placed behind guard rails as a double precaution for safety where needed	12,638 lin. ft.
Sodding	433,530 sq. ft.
Planting trees, shrubs and wild flowers	86,700 sq. ft.

COST	Labor	Material	Total
Road construction	$1,235,696.09	$ 85,674.83	$1,321,370.92
Truck repairs	8,291.10	12,932.54	21,223.64
Machinery repairs	1,429.65	10,998.70	12,428.35
New equipment (jap hammers, tools, etc.)	57.60	2,878.97	2,936.57
Grand totals	$1,245,474.44	$112,485.04	$1,357,959.48

Cost per mile (5½ miles), $246,900.

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$3,000,000 Bridge to Be Built in British Columbia.—Tenders were opened June 10 by the Minister of Public Works, Victoria, B. C., for the construction of a bridge over the Fraser River, to cost about $3,000,000.

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12,700 Miles of State Roads in Italy.—The Italian State Road Board, with main offices in the Ministry of Public Works has reported that on June 30, 1934, there were 20,687 kilometers (12,700 miles) of State roads in Italy. These comprise the main national routes. Since the creation of the Azienda (Board) in 1928 the expenditures have been 1,237,229,000 lire.

Highway By-Products and Freeways

To the Editor:

I had just prepared the following statement on freeways when I ran across your editorial, "Highway By-Products," in Roads and Streets for May, 1935. What you say is true in regard to those who operate along our main highways, and who have certain commercial interests, but I am trying to consider these main highways from the standpoint of their social utility. My general point of view is brought out in the statement.

The terrific expense of unprotected highways is already so great that it would seem as though our attention should be forcibly drawn to the matter. On top of this we know that these ways are dangerous and that they are far from beautiful.

A member of our legislature said about four years ago that our main highways should be as stimulating to the eye as they are to the speedometer. This statement, Albert Payson Terhune said, was sheer genius, and that he had often written ten pages without saying any more.

I doubt very much whether it will ever be possible to convert any of our present highways into freeways. They have already been so much spoiled that the expense would be prohibitive. It seems high time for us to establish this principle for new highways and we are going to have to have new ones because the present ones will be so absorbed by local traffic and business that they cannot clear the traffic, they cannot be safe, and they cannot be beautiful.

E. T. Hartman,
State Consultant on Planning,
Department of Public Welfare,
Boston, Mass.

Freeways

A freeway, limited way, steadyflow way or townless highway, is a way devoted to traffic. Mr. Edward M. Bassett defines it thus: "A freeway is a strip of land devoted to movement over which the abutting property owners have no right of light, air or access." A freeway is much like a railway, where, as pointed out by the New England Regional Planning Commission, there is provided: 1. Separation of opposing lines of traffic. 2. Grade-separation or rotary traffic design of intersections. 3. Adequately wide right-of-way over which the state exercises control of commercial uses and of access from adjoining property; access is permitted only at properly designed entrances. 4. Provision for footpaths, where pedestrian traffic justifies, along the highway and over bridges. 5. Proper curves, banking and visibility for fast moving traffic.

The purpose of such a way is economy, safety and beauty. The fatal expense, terrific traffic hazards, and destruction of natural beauty resulting from present methods will force action in time. If eventually, why not now?

Take the Boston and Worcester road as an example. It cost $175,000 per mile. It is a four-lane way, two for rapid traffic and two for slow traffic. Unprotected, it will soon be lined with filling stations, hot-dog stands, dance halls, billboards and other commercial junk. This causes the parking of cars and people going into and across the road. A car parked every quarter mile will kill one lane on each side. There are left but two lanes, controlled by the slowest-moving vehicles. It will require three such ways to clear the traffic one freeway will clear with ease.

The greater safety of a freeway is obvious. To have no border use of the land, no running in and out and across, no parking, no interference of any kind, will promote safety in a most effective way. Killing 34,000 people, injuring over a million, with automobiles every year is senseless. One per cent of the people, and more, killed or injured every year, is not only senseless, it is criminal.

All intelligent people are interested in and enjoy natural beauty. We boast of our natural beauty and ask people to come here to see it. The main chance to see it is from the highways. But we get no chance to see it except through a screen of roadside desecration which reflects no credit upon us.

Mr. Bassett says that "if states did not have highway departments, the states could build freeways with less trouble than they can now. The trouble is that a highway department has no power to build anything but highways. The simple method of statutory procedure is to amend the highway law to define a freeway. Then provide that the highway departments can build freeways the same as highways." Why is it that, in the name of economy, planners and legislators refuse to take action? And picture the condition of a town with three such ways, perfect automobile slums, running through it!

Parkways, 300 ft. wide, would be far cheaper than the present method. But parkways are not necessary, in many ways not even desirable. It is natural beauty that the people desire. We need to take but 100 ft., as now, and apply the freeway principle.

Do we need more space for business? We do not. We already have zoned for, or spoiled by, business five times as much area as will ever be economically and soundly developed. Our present state highways in Massachusetts provide business space enough for 50,000,000 people. Very little of this area will ever be desirably developed, the ways will remain fringed with desecration, economy, safety and beauty gone in a puff, all because we refuse to act sensibly. We insist upon finely surfaced roads, "fringed with filling stations and hot-dog stands, . . . through endless miles of wilderness and desolation."

A provision to cover the need was presented in one of the state planning board bills this year, but it receives no consideration. It will continue to be ignored, with the results as pointed out, until planning board members and others who are interested in economy, safety and beauty become vocal. Pious wishing will produce no proper action.

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$400,000,000 Apportioned for Roads and Grade Crossing Work

Secretary of Agriculture Henry A. Wallace on June 4 announced the apportionment among the States, the District of Columbia and Hawaii of $200,000,000 for highways, roads and streets and $200,000,000 for elimination of hazards at railroad grade crossings under the Emergency Relief and Appropriation Act of 1935. These sums are allocations made by the Advisory Committee on Allocations on May 16 and approved by the President.

The expenditure of the new funds is subject to such rules and regulations as may be prescribed and approved by the President.

An additional $100,000,000 was allocated by the Advisory Committee on Allocations with which to meet obligations arising from the authorization of $200,000,000 for highways in the Hayden-Cartwright Act and apportioned by the Secretary of Agriculture on June 19, 1934. One-half of this amount has previously been appropriated.

The funds apportioned are not available for expenditure in any State until a program of the projects proposed to be undertaken in the State shall be submitted by its highway department and approved by the Advisory Committee on Allotments.

It is also provided that no individual project will be approved for construction in any State until the highway department of the State has submitted and obtained approval of a program of projects that will absorb substantially all Federal emergency funds previously apportioned.

Subject to these conditions the funds are available for immediate expenditure and will be administered through the Bureau of Public Roads. They are to be expended by the State highway departments and it is expected that construction on many projects will begin in the immediate future.

The apportionment is as follows:

APPORTIONMENTS TO STATES

State	Highways, Roads, and Streets	Elimination of Hazards Railroad Grade Crossings	Total
Alabama	$4,151,115	$4,034,617	$8,185,732
Arizona	2,569,841	1,256,099	3,825,940
Arkansas	3,352,061	3,574,060	6,926,121
California	7,747,928	7,486,362	15,234,290
Colorado	3,395,263	2,631,567	6,026,830
Connecticut	1,418,709	1,712,684	3,131,393
Delaware	900,310	418,239	1,318,549
Florida	2,597,144	2,827,883	5,425,027
Georgia	4,988,967	4,895,949	9,884,916
Idaho	2,222,747	1,674,479	3,897,226
Illinois	8,694,009	10,307,184	19,001,193
Indiana	4,941,255	5,111,096	10,052,351
Iowa	4,991,664	5,600,679	10,592,343
Kansas	4,994,975	5,246,258	10,241,233
Kentucky	3,726,271	3,672,387	7,398,658
Louisiana	2,890,429	3,213,467	6,103,896
Maine	1,676,799	1,426,861	3,103,660
Maryland	1,750,738	2,061,751	3,812,489
Massachusetts	3,262,885	4,210,833	7,473,718
Michigan	6,301,414	6,765,197	13,066,611
Minnesota	5,277,145	5,395,441	10,672,586
Mississippi	3,457,552	3,241,475	6,699,027
Missouri	6,012,652	6,142,153	12,154,805
Montana	3,676,416	2,722,327	6,398,743
Nebraska	3,870,739	3,556,441	7,427,180
Nevada	2,243,074	887,260	3,130,334
New Hampshire	945,225	822,484	1,767,709
New Jersey	3,129,805	3,983,826	7,113,631
New Mexico	2,871,397	1,725,286	4,596,683
New York	11,046,377	13,577,189	24,623,566
North Carolina	4,720,173	4,823,958	9,544,131
North Dakota	2,867,245	3,207,473	6,074,718
Ohio	7,670,815	8,439,897	16,110,712
Oklahoma	4,580,670	5,004,711	9,585,381
Oregon	3,038,642	2,334,204	5,372,846
Pennsylvania	9,347,797	11,483,613	20,831,410
Rhode Island	989,208	699,691	1,688,899
South Carolina	2,702,012	3,059,956	5,761,968
South Dakota	2,976,454	3,249,086	6,225,540
Tennessee	4,192,460	3,903,979	8,096,439
Texas	11,989,350	10,855,982	22,845,332
Utah	2,067,154	1,230,763	3,297,917
Vermont	924,306	729,857	1,654,163
Virginia	3,652,667	3,774,287	7,426,954
Washington	3,026,161	3,095,041	6,121,202
West Virginia	2,231,412	2,677,937	4,909,349
Wisconsin	4,823,884	5,022,683	9,846,567
Wyoming	2,219,155	1,360,841	3,579,996
District of Columbia	949,496	410,804	1,360,300
Hawaii	926,033	453,703	1,379,736
Engineering and Administrative Reserve	5,000,000	4,000,000	9,000,000
Totals	$200,000,000	$200,000,000	$400,000,000

The Finished Surface of a Stabilized Road in Oakland County, Michigan

STABILIZED SURFACES IN OAKLAND COUNTY, MICHIGAN

By JOHN H. BARR

Road Engineer, Oakland County Road Commission, Pontiac, Mich.

THE problem of road maintenance in Oakland County has never been an easy one. With an increase of maintenance and a decrease of revenue, the problem has become even more difficult. Since funds were tied up in closed banks and property tax for highway purposes were eliminated, expensive road construction has had to cease. The only money available for maintenance purposes is received from state gas and weight tax. As collections from these sources were low during the past three or four years, maintenance of highways, and especially gravel roads, has fallen below the standard of previous years. For these reasons it was deemed advisable to select some low cost type of road surface which would prove more satisfactory than gravel, as commonly applied, and which we believed would reduce the average cost of upkeep per mile.

With the above idea in mind it was decided to stabilize our ordinary gravel road surface with the addition of clay. An investigation, however, disclosed the fact that during past few years of minimum expenditures we had lost much of our road metal and most of these gravel road surfaces were of insufficient depth and width. It was decided, therefor, to build up new mats on our old gravel road bases. Enough new material was added to produce a wearing course of gravel three inches in thickness and twenty feet in width. To this quantity of gravel the correct amount of clay was added, as determined by laboratory tests.

In the fall of 1932 a section of the Andersonville Road, three miles in length, was selected for the experiment with this low cost type of construction. The gravel and clay were added and mixed in the correct proportions and a tightly bound surface was produced. Light applications of calcium chloride were spread occasionally during the next season to maintain a comparatively dustless surface. The experiment was successful enough to warrant further trial of stabilization on roads of heavier traffic than that of the Andersonville Road, which carries approximately 300 vehicles per day. A continuance of a stabilized surface program saw the completion of 25 additional miles in 1933 and 22 more miles in 1934. The program for 1935 includes 20 miles of stabilization.

Preliminary Investigation.—One of the first steps in the construction of stabilized roads is the locating of adequate material in proximity to the various projects. Oakland County is blessed with gravel deposits so that the problem of soil location resolved itself into one of obtaining the required quality and quantity of clay. During the 1933 and 1934 season only three large deposits of satisfactory clay were located, and these were at extremities of the county, necessitating many long hauls.

It is not intended to go into a discussion of clays other than to say that these clays best suited for this work in our county had a plasticity index of 18 or more. The plasticity index, or P. I., is a measure of the stickiness and binding property of the clay. This test is performed on the screenings passing a No. 40 sieve. The test is used, not only for comparing clay properties, but

Clay Delivered and Windrowed

also for determining the binding property of the fines in stabilized gravels.

When the soils have been located, tests are made in our own soils laboratory, to determine the advisability for use in stabilization. Screen analyses are made of both clay and gravel, and the percentages passing a ½ in., a No. 4, No. 10 and No. 40 sieve are determined. The material passing the No. 40 sieve is saved, and the P. I. test is made on this fraction. When the tests have been completed the pits are then designated from which the materials are to be used.

Method of Construction.—Although many discussions of methods are available, our projects differed from most others in that resurfacing material was used throughout. It has been found convenient to work each project in one-half mile sections, and the method used is as follows:

First: All loose material on the roadway is windrowed to the center.

Second: Enough new material is added to the windrow to bring the total quantity to approximately 1,000 cu. yd. per mile. This amount is determined by measuring the windrows. This quantity, when stabilized, will produce a wearing course 3 in. in depth and 20 ft. in width.

Third: Clay is then delivered and windrowed on each shoulder, in sufficient quantities to produce a stabilized mix of the desired P. I., the quantity having previously been determined by test in our soils laboratory.

Fourth: As soon as the clay has become dry, it is spread out, pulverized, and bladed back into its original position on the shoulders.

Fifth: The gravel windrow from the center is then spread between the rows of clay and the pulverized clay is spread uniformly over the gravel. Calcium chloride is then applied at the rate of 4 tons per mile on top of the clay.

Sixth: The mass is then thoroughly mixed by blading, and after mixing, it is split into windrows on each shoulder of the road.

Seventh: The base is then uniformly moistened from water tanks, and a small amount of the mixed material is bladed from the windrows on to this surface. This is then similarly moistened and covered as before and these operations are repeated until all of the dry material has been placed. During this process, traffic has been allowed to travel over the bladed material, and compaction has been started. When all the material has been placed and a crown of not less than ½ in. per foot has been established, the surface is then smoothed and traffic is allowed to continue compaction for a period of from 24 to 48 hours before the final smoothing takes place. There seems to be quite a difference of opinion concerning the amount of water necessary in laying this mix. Too many factors enter into this operation, in our opinion, to definitely set a required amount. We have used as low as 7,000 gal. of water to as high as 30,000 gal. of water per half mile. These were extremes. The average, per half mile, however, has been fairly high during 1934, amounting to approximately 20,000 gal. This quantity was required with only a 1,000 gal. tank truck operating. Two such tank trucks will cut this amount of water considerably, as less evaporation takes place.

Eighth: After this consolidating period, a patrol grader makes the final smoothing of the surface. By this time a slight amount of loose material has usually developed. The surface is then sprinkled just enough to allow traffic to compact the loose material and incorporate it into the surface. When, because of cold or wet weather, calcium chloride has not been included in the mix, it is then applied to the surface at the rate of 3 tons per mile.

Plant Mix.—The plant mix stabilization, of which we have done a small amount, varies only in that clay and gravel are combined at the pit wherever possible. Most of the Oakland County gravel pits are free from clay. However, one of the county gravel pits was covered with a 6 ft. layer of clay having a P. I. of 16. No special equipment was used to segregate and add the clay to the gravel in correct proportions. However, by means of a hand spudding and by careful manipulation of the drag line, a fairly good stabilized mix was delivered from the screening plant. A one mile project was built from this pit in which the material was mixed at the plant. Tests indicated that closer control was desirable, and an effort was made to improve the composition at the pit. On additional mileage built from the pit it was necessary to add a small amount of the strippings from this same pit, on the road, in order to secure the desired quantity of fines.

The work that has been done on the study of plant mix in Oakland County warrants further investigation. Tests have been made that indicate that mixtures of waste strippings which contain low P. I.'s, mixed with graded pebble, will produce a stabilized mix. There is every reason to believe that very soon a plant mix will be produced that will eliminate all the operations of hauling clay, pulverizing, mixing and sprinkling in place. This will result in a considerable saving of time and in a lowering of the cost of construction.

Construction Costs.—Costs per mile of construction have varied from one project to another, depending on the quantity and quality of soils to be stabilized, as well as the length of the hauls. The total average cost per mile of projects 3 in. depth and 20 ft. in width, including 850 cu. yd. of gravel at $892.00, and equipment rental and operations, clay and calcium chloride at $758.00, has been $1,650.00. Average costs of clay have been $1.50 per cubic yard spread on the job and for gravel $1.05 per cubic yard delivered. Gravel is produced by reg-

Spreading the Gravel Preparatory to Spreading Clay

Gravel in Center; Clay on Sides

ular pit equipment, while clay is produced by hand labor. Water costs have averaged $50.00 per mile. The cost of the finished wearing course per square yard mixed in place has averaged 14 ct. Our plant mix showed a slightly lower cost, approximately 12 ct. per square yard, or an approximate saving of $200.00 per mile.

Specifications.—Thus far we have made little mention in this paper of our specifications of stabilized mixes. A discussion at this point will show the progress that has been made in the adaptation of this type of surface to our materials.

From the fall of 1932 until July of 1933 the first project showed very little wear and only occasional blading was required. Original specifications for stabilized material called for gravel containing 25 per cent fines passing a No. 40 sieve, and having a plasticity index of 5. However, as the program for 1933 was to be placed on roadways carrying considerably more traffic than the first project, it was thought advisable to increase the P. I. of the mix to 8. This increased stickiness was desired to prevent ravelling. Being rather skeptical of results, and fearing that during wet weather rutting and slipperiness might develop from too much clay, it was our inclination to favor the production of a mix of a P. I. of less than 8 rather than over. Tests were made occasionally during the season and resulting mixes showed an average P. I. of 7 and with less than 20 per cent of fines passing a No. 40 sieve. However, in spite of the increased P. I., during the early summer of 1934, which was notable for its lack of moisture, some of the more heavily traveled projects, carrying approximately 2,500 vehicles per day, began to ravel and develop loose aggregate. To correct this condition water trucks and patrol graders were placed on the jobs. The surface was moistened with approximately 4,000 gal. of water per half mile and the loose material was incorporated into the surface by blading. After having to repeat this operation a number of times on the same projects tests were made of the loose material. It developed that this loose material showed no plasticity index and that most of the fines were gone. Clay, approximately 40 cu. yd. per mile, had to be added to this loose gravel. The two were mixed, sprinkled and bonded to the surface and calcium chloride was applied.

The need for this treatment, to bind the loosened aggregates, indicated the desirability of increasing the fines content and the plasticity index or stickiness of the mix on future construction. In the latter part of the 1934 construction program, this was taken into consideration and a closer control of the materials and the mix was attempted. Samples were taken and tests made each day and a rigid effort made to maintain a plasticity index not less than 10 and to increase the fines to between 25 per cent and 30 per cent. Results of tests from the final mixes taken from each half mile laid during the latter part of 1934 showed the following average analysis:

	Per Cent
Passing ¾ in.	100
Passing ½ in.	90
Passing No. 4	70
Passing No. 10	50
Passing No. 40	30

With P. I.'s averaging at least 10.

These limits seemed to give somewhat better results than those obtained during the 1933 construction season as regards ravelling.

Another change made in the summer of 1934 in trying to eliminate so much ravelling, was the introduction of calcium chloride within the mix. This was first tried on a ½ mile section of a 10-mile project. Some of the advantages noticeable with this admixture are included in the following: There was less loss of fine during the mixing process; less water was necessary when laying the material; the surface developed seemed somewhat harder; less loose material developed when compared with sections on each end of the admixture section; and the length of time the section remained dustless increased considerably over the previous method. For these reasons the admixture method was used during the remainder of the 1934 construction program. During the late fall the admixture miles remained much smoother than those not so treated. However, final conclusions regarding this method will not be available until the middle of 1935 at which time we hope to have some very definite results concerning admixture stabilization.

Maintenance.—Maintenance of stabilized surfaces in Oakland County has been, as one of our district men expressed it, rather a ticklish proposition. There has been little information advanced on this point and much of the information that we now have, has been learned by doing. That perhaps is one of the reasons why maintenance has been quite a problem in our county.

Another reason for this, however, in the summer maintenance of this type of surface, was the inability to get equipment to the project at the proper time to blade. There is an old saying that "Time and tide wait for no man." To this we might add, "nor does the weather."

It was found that summer rains were not sufficiently prolonged to penetrate the stabilized surface deep enough to permit smoothing, nor did the rains come at the right time. Blading during a light summer rain or even a heavy rain, usually caused the road surface to dry out, with the result that there was not enough moisture content retained in the material to allow compaction after blading; and as a usual thing, following this operation

Clay and Gravel in Windrows. On Narrow Road Clay Was Placed Between the Wheel Tracks

during the summer, an application of water was found necessary. For these reasons we have not relied on weather for our maintenance, but have applied water to the projects by means of a 1,000 gal. tank mounted on a truck. Luckily Oakland County is blessed with plenty of lakes where we were always able to obtain the necessary water for the work. Without this condition, maintenance during the past season would have been even more difficult. During the greater part of 1934 we had but one such tank for this purpose. One tank was not sufficient for both maintenance and construction, so that another tank of like capacity was purchased in the latter part of the season. This was a decided help to us and should prove even more so on maintenance during the summer of 1935.

As soon as a project needs attention, a grader is sent to smooth the surface, if it is not too rough, and enough water is applied to the surface to allow compaction of the loosened material. Where the surface has been allowed to go too long without attention, water is first applied to moisten the metal. The surface is then cut ½ to 1 in. deep, and mixed with the loose material, and after smoothing it is given a light sprinkling of water. Calcium chloride is then usually applied. Wherever holes have developed in the surface, but not enough to warrant disturbing the whole project, patching, with a mixture of clay, gravel and calcium chloride, has been done. This has been quite satisfactory and has usually been sufficient until such time as it has been necessary to sprinkle and smooth the entire project. As already stated it has been necessary to add a small amount of clay to these projects which have developed too much loose material and where the P. I. of the surface has been reduced considerably due to loss of binder. This feature was explained in detail previously in the paper.

Results.—Although we have felt that maintenance costs have been somewhat higher and calcium chloride requirements somewhat greater than we had anticipated, nevertheless, the stabilized surface has been more satisfactory than the ordinary gravel road. Some of the advantages of this type over the common gravel road are as follows: They result in tightly bound surface and are free from loose gravel: with light applications of calcium chloride a practically dustless surface can be maintained; there is no appreciable loss of gravel due to traffic; considerable patrol grader work is eliminated, and an ideal base is provided for stage construction.

As stated, there has been no appreciable loss of gravel on stabilized surfaces. However, it has been necessary to add 40 yd. of clay per mile to rebind some of the surfaces built during 1933. Since our higher traffic gravel roads have required approximately 2 in. of gravel resurfacing every three years, the average yearly cost for material, using the stabilized surface should be considerable under that of the ordinary gravel road. In our opinion, the calcium chloride admixture type of stabilized surface should bring about a further reduction of material losses.

The Mix Being Moistened with Part of the Moistened Material Spread

1,000 *Gal. Water Tank Mounted on Truck*

During the 1935 period of maintenance a few outstanding facts have been noticeable, namely:

(1) Surfaces have been bladed a maximum of eight times during the past year.

(2) Calcium chloride has been spread on an average of three times.

(3) The average application per mile for calcium chloride has been a trifle over eight tons.

(4) Light applications of calcium chloride at shorter intervals have worked to better advantage than heavy applications at longer intervals.

(5) Stabilized surfaces have a tendency to retain a heavier icy condition than the ordinary gravel surface.

(6) Stabilized surfaces have not rutted during heavy rains. During the first rains following construction, a film of sand clay developed and causes a muddy surface condition. However, as the project ages, this condition decreases materially. On solicitation from residents along such highways the general attitude has been that this condition is negligible in comparison to the benefits derived from this type of surface.

Maintenance Costs.—Costs of maintenance on seven projects for 1934 have varied from $265 per mile to $415 per mile. The average cost per mile for 18 miles has been $320. This includes the item of equipment rental. Although these costs are comparatively low, nevertheless, it is hoped that with the experience of the past year and with the various changes made in construction and specifications during the latter part of 1934, even lower costs will result.

The foregoing is a paper presented at the 1935 Michigan Highway Conference at University of Michigan.

▼

Traffic Rules for Madrid.—According to a press dispatch new traffic regulations recently put into effect in Madrid include the following: Persons who form groups on the pavement, disregard traffic signs or cross streets at places other than marked crossings will hereafter be fined from 25 to 50 centimos (3 to 6 cents). A fine of 1 to 2 pesetas (12 to 25 cents) will be levied on motorists who drive without lights or on the wrong side of the road.

EDITORIALS

The Menace of a Long Drought

THE longest drought experienced since the white man came to this continent was the one that the Spanish "padres" recorded in California shortly after they established missions there. That drought lasted 29 years. Its length should serve to call a halt upon the optimistic prophesies that wet years will now succeed the very dry years that began in 1929. We mention that 29-year drought less as a warning to optimistic prophets than as evidence of the 152-year weather cycle that was discussed by Halbert P. Gillette in a recent issue of this magazine. In that article it was stated that the annual rings of the Arizona pines show a cycle of 152 years whose last rain maximum was about 1863. Incidentally it may be well to add that that was the year of greatest rainfall in Utah, and that Great Salt Lake reached its highest level then. Its lowest level occurred last summer.

If 1863 was a "peak" of the 152-year rain cycle, 1939 would be its next "valley" or minimum. This cycle is usually characterized by very dry years for 15 years before and after a "valley." If 1863 was a "peak" the previous "valley" should have occurred about 1787, and it did in California and presumably elsewhere in the semi-arid regions of the west and in the upper Mississippi Valley. But California was then the only region west of the Mississippi that was inhabited by white men, so we must look to California records for evidence of that drought. Fortunately the "padres" kept very careful records of crops raised at the missions between 1769 and 1832, and, in addition, wrote many letters commenting upon the weather. Those records have been thoroughly studied by H. B. Lynch, Consulting Engineer, who made a report to The Metropolitan Water District of Southern California. The report was published in 1931. We quote from it:

"In 1781 began a period of rainfall shortage which lasted, with only occasional small interruptions, until 1810. The total rainfall deficiency in this period was as great as any of which we have record. Some of the other droughts have been more acute, but of lesser duration. The extent of this drought is told in crop reports and in many references to the character of the seasons. It is also confirmed by a reference to the condition of Lake Elsinor, which in 1810 was little more than a swamp about a mile long. The drought was state-wide and all of the missions experienced the same difficulties."

As another confirmation of the date of that drought, we may cite the fact that New South Wales, Australia, was settled in 1788 during a drought from which there was not a year of let up till 1795 when the first important rainfall occurred. It is spoken of as "a frightful drought." Probably it began several years before 1788 and recurred again after 1795, but no records are available as to that.

Too many great famines have occurred near minimum rainfall dates of the 152-year cycle to be accidental, but more convincing than all such records is the tale of the tree-rings and of the "varves." They make it clear that this cycle is of great amplitude, of great regularity and has little or no variation as to length. There are 9 important short cycles, ranging from about 2 to 33 years in length, and when the "peaks" or "valleys" of several of them nearly concur they may offset the effect of the 152-year cycle, but only for a short time.

Last summer the Colorado River was nearly dry, and consequently there was insufficient water for irrigation in the Imperial Valley in southern California. Although the Hoover Dam has begun to store the waters of the Colorado, it is not impossible that by 1939 there may be almost no runoff to store.

Not only are many water supply and water power plants in grave danger of becoming useless during the coming drought, but great farming areas will probably be abandoned. Moreover governmental projects to prevent "erosion" of soil by winds will be futile if this great drought runs true to the form that is disclosed by the rings of the Arizona pines during the past five centuries. The proposed $75,000,000 "Shelter Belt" of trees 100 miles wide, from the Canadian border to Texas, has little enough to recommend it at best. But if the trees are planted during a prolonged drought they will never mature. Even the mature trees in many existing wind-breaks died last year. What chance, then, have tree seeds or seedlings?

Great areas throughout the world face at least 25 years more of subnormal rainfall. The arid and semi-arid regions will suffer the most, but even regions that ordinarily are well watered will not entirely escape. We should not speak with such assurance were it not that the 152-year cycle has recorded its existence in tree-rings as far back as 1255 B. C. when a long drought was at its height as shown by the rings of the giant redwoods of California. The annual clay-layers ("varves") deposited in lakes during the last Ice Age also show this cycle. During the Ice Age great moraines were deposited during halts of the retreating ice-front at regular intervals, and these intervals were about 152 years, as disclosed by a study of the annual "varves." A weather cycle capable of forming long series of such moraines (e.g. 14 in the Berkshire Hills in Massachusetts) is one that is in a class by itself.

Had the existence of the 152-year cycle been fully established two years ago, our Department of Agriculture would not have advocated the curtailment of crops and the slaughter of stock. Yet as far back as 1914 Prof. Ellsworth Huntington of Yale had found good evidence of this cycle in tree rings, and four years prior to that, an Australian civil engineer, T. W. Keele, had found it in the floods of the Nile and in Australian rainfall. But cycle researchers either had not read the papers by those two men, or had not believed that their discoveries merited further investigation.

The economic importance of this cycle is so stupendous that no expense should be spared in determining the reliability of the claims originally made for its existence by Keele, by Huntington and, more recently, by Gillette. These claims are based upon many different kinds of data, modern and ancient, man-kept and nature-kept, the latter being, by all odds, the most convincing.

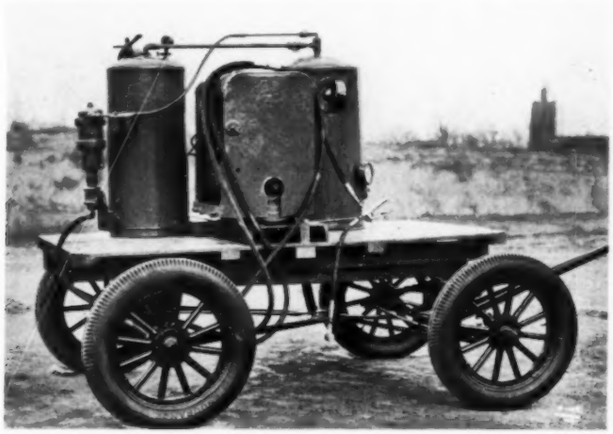
It is perhaps not putting it too strongly to say that the tree-ring measurements of Douglass and of Huntington and the annual "varve" measurements of De Geer and of Antevs are the basic data upon which will be founded a theory of weather cycles that will revolutionize meteorology.

NEW EQUIPMENT AND MATERIALS

Portable Powergun for Lubricating Equipment

The Alemite Corporation, 1874 Diversey Parkway, Chicago Ill., has designed and offered for sale pneumatic power-guns to meet the exacting demands of lubrication maintenance in the construction field. The installation pictured here is a typical example of how an Alemite unit of this type can be fully utilized.

The unit tank on the left has a capacity of 200 lb. of grease and is powered by a high pressure pump, capable of ex-



Portable Powergun Lubricating Outfit.

erting pressures 40 times the air pressure used. The air tank on the right furnishes the power developed by a gasoline-driven air compressor (shown in the center). With but little effort tons of pressure are always available at the operator's finger tips.

Note that the system is mounted on a trailer to give ready portability in lubricating a large construction outfit. In many instances trucks are utilized for this purpose, carrying in addition electric light plants to furnish illumination for lubrication done at night, as well as storage drums for grease and oil.

Besides the Unit System, other Alemite guns are available to do the same efficient work: Alemite HP barrel pumps apply grease under pressure directly from the original containers into the bearings, completely eliminating handling of the grease with its accompanying danger of contamination. The Alemite "Rock Crusher" is another power-gun designed particularly to handle the most fibrous and the heaviest greases obtainable.

▼

New Wagon Scraper

A new wagon scraper (the Continental) brought out recently by the Continental Roll & Steel Foundry Co., East Chicago, Ind., is a complete dirt-moving unit of full 5-yd. capacity—and one that is handled readily by the "35" and "40" crawler tractors—yet will stand the "gaff" of the larger tractors. It is a "one-man" controlled outfit throughout.

The Continental is a combination scoop-up and carry scraper; a hauling dump wagon and a distributing unit—all operations performed with only one handling of the dirt or other material. The material hauled can be deposited in any desired manner. In addition to windrowing and stock-piling, the Continental will dump backward, just like a truck. All dirt is dumped to the rear of the machine.

The Continental wagon scraper will scoop its own load, or it can be used in a fleet of dump wagons or motor trucks under an elevating grader, power shovel or drag line. Operators maneuver the scrapers into position very readily. They can be pulled into loading position, or backed into position up steep banks and through soft soils.

These units are designed and constructed for heavy digging work, yet they can be hurried over all types of surfaces when

Scooping a 5-yd. Load in a Continental Wagon Scraper with a "40" Crawler Tractor.

loaded. Alloy steels are used throughout and the latest methods of fabrication employed. The frame is a one-piece "Dynamic Steel" casting. The bucket, dirt-carrying extension apron and rear door are alloy plate. Electric welding is used throughout.

The wagon scraper is carried on two low-pressure pneumatic-tired wheels, which are mounted on high-grade roller bearings. All operations of the wagon scraper—scooping, hauling and dumping—are controlled hydraulically by one lever convenient to the operator.

▼

Ford V-8 Truck Mounting for Lorain Crane

The Universal Crane Co. of Lorain, O., has announced a Ford V-8 truck mounting for their Lorain 30 truck crane.

Previously this crane turntable has been mounted only on trucks of 5-ton or heavier capacity, but the unit has now been made available for mounting on a Ford V-8 truck without loss of rated capacity.

The truck is a standard Ford V-8 truck in all particulars except that an auxiliary or third axle (any of several standard makes) must be added together with lengthening and reinforcing of the truck chassis frame, as is usual in all cases when a third axle is added to permit the use of such a truck under heavy-duty service with loads of greater than rated capacity.

Lorain 30 Truck Crane Mounted on Ford V-8 Truck

The crane turntable is a standard Lorain 30 turntable, full revolving, one-man operated, gasoline-powered unit, equipped with a 25-ft. boom. With outriggers set, it has a lifting capacity at 10-ft. radius of 13,050 lb. Without outriggers set, its lifting capacity over the back at 10-ft. radius is over 4 tons.

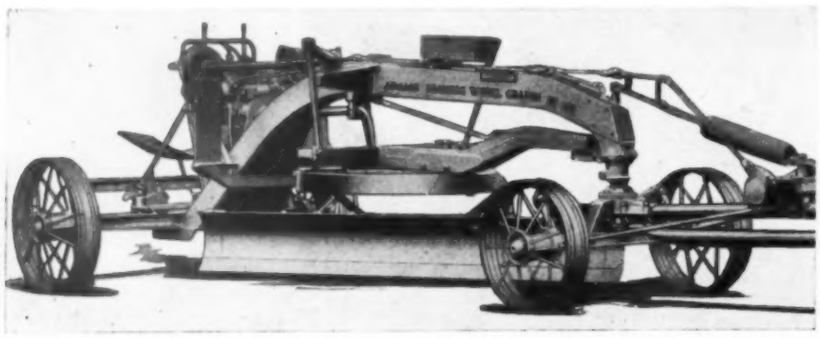
In order to preserve the all-weather cab on the truck and yet develop the low traveling clearances necessary on city streets, a special 25-ft. boom has been developed for these units. This boom has a hinge connection at the center so the top section can be lowered and held in place by a couple of links, and thus provide the necessary low overhead clearances. For operation, the links are quickly removed and the boom is made into a rigid, straight column like any other boom.

The truck is equipped with specially designed stabilizing jacks and stirrups which transfer crane loads directly into the two rear axles for crane operation, and eliminate all spring action, thus giving a rigid rear end. Jacks and stirrups are quickly released to permit normal rear spring action when the unit is in transit. Jacks and stirrups are arranged so that they in no way encumber the rear wheels, which are always free to turn so the unit can be driven safely with loads suspended from the crane boom.

▼

New Leaning Wheel Graders

Concurrent with the observance of their 50th anniversary, J. D. Adams Co. of Indianapolis, Ind., announces four new-type leaning wheel graders which they claim set a new high mark in mechanical excellence and operating advantages. The design is along modern lines, featuring extreme simplicity, strength, rigidity, and a wider range of blade working positions without mechanical adjustments.



Adams New Leaning Wheel Grader

The most outstanding and apparent feature is a new all-welded, box-type frame made of heavy ship channels welded their entire length. The new frame, it is claimed, is not only much more rigid and 100 per cent stronger against twisting stresses than previous Adams frames, but affords valuable operating advantages. From the front end of the frame to a point well back of the blade circle (where it spreads to connect to the rear axle) the frame is only 7 in. wide. This permits absolute freedom in the rotation and throw of the blade lift arms and lifts links so that the blade can be swung through an arc of more than 90 degrees from ditching position to perpendicular, and this without any adjustment of the lift links. It is claimed that fully 90 per cent of all road grader work, from ditching to back-sloping and bank-cutting, can be done with these graders without any change or adjustment of lift links or shift of moldboard on the blade circle. The narrow frame and all-round simplicity of the grader also affords the operator extraordinary visibility so that he can always see the full length and observe the work being done.

These new machines embody several new mechanical features also. Built-in anti-coasting devices are provided on operating adjustments which automatically lock adjustments in position until changed by the operator. These devices require no attention whatever on the part of the operator—they unlock automatically when any control goes into operation and lock automatically the instant the adjustment is completed. On power-controlled machines the control which sets the angle of the blade is self-locking in any position; it employs no locking pin and the angle of the blade can be adjusted readily while the blade is at work. This is particularly valuable on bank work.

Other mechanical features include machine-cut and enclosed gears throughout with worm shafts mounted on Timken roller bearings; machine-finished bearings, ball and socket lift link and moldboard connections; machined blade circle for close fit and easy operation; ball and socket connection to front axle; gear-operated, trouble-proof steerable tongue with enclosed shock-absorbing spring and wide-tired, tractor-type wheels mounted on Timken roller bearings.

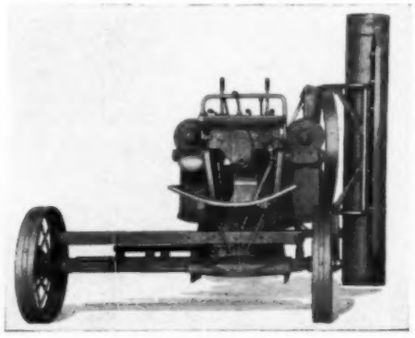
The new graders are offered in 10 and 12 ft. blade lengths and with hand or power operated controls; the latter are highly recommended because of the rapidity with which adjustments can be made with practically no effort. It is claimed that the blade can be raised from plowing position to perpendicular in 40 seconds and that other adjustments are correspondingly fast.

▼

New High Speed Hauling Unit

A new high speed dirt hauling unit which has been put through rigid tests by contractors for several months is now announced as ready for distribution by the Allis-Chalmers Tractor Division, Milwaukee, Wis. Specifically designed for high speed hauling, and to combine these high speeds with unusual mobility and ease of control, the new unit is known as the Speedster. It is stated to be able to haul 6 to 8-yd. loads at speeds ranging up to 16 miles an hour. It is a single-unit outfit, consisting of trailer-type wagon and tractor, with six big low-pressure tires. Drive wheels of the tractor carry a part of the load weight, assuring ample traction under all conditions.

Because of their large area in contact with the soil, the 18 in. by 60 in. tires are stated to have proved their ability to carry heavy loads through soft, uneven ground, up or down steep slopes, and through sand, mud or gumbo. At the same time they permit high speeds to and from the dump.



Grader with Blade Raised

A new type of cushioned hitch is used to provide unusual stability without sacrificing flexibility. It consists of a complete universal joint stabilized with two large rubber cushions to prevent side sway. A special low hitch, below and ahead of the

The New Allis-Chalmers Speedster

The Best Wear and Tear Insurance You Can Buy

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drive axle center, prevents any tendency of the tractor to rear. High clearance eliminates the possibility of "hanging up" on the dump.

The Speedster's ability to "turn on a dime," at greater than 90 degree angles, is another unusual feature in this unit. A high arch provides clearance for the tractor to undercut and to turn in its own tracks for quick, accurate spotting under dipper or grader. Steering is assisted by independent clutches and brakes.

One man operates the entire unit. Braking, dumping and winding operations are vacuum controlled from the tractor dashboard. The all-welded design produces maximum strength with minimum weight, and the torsional tube main frame eliminates twisting strains from the body. A wide, unobstructed bottom dumping mouth discharges loads instantly. The open hopper top has a reversible side for low loading operations when needed. Anti-friction bearings are used throughout.

▼

New Type Jaeger-Lakewood Finisher for Large Tunnels

The building of the Metropolitan Water System between the Boulder Dam and Los Angeles called for the mechanical finishing and vibration of the concrete in the invert of these large tunnels. The illustration shows one of the three machines now in use on this work by Thompson-Starrett Co., Barrett-Hilp and Macco Corporation, and the Griffiths Co., one of these machines being equipped with electric vibratory motors on the front screed together with an independent motor generator set for furnishing the current.

The machine as illustrated is set for 20-ft. width, the screed

Jaeger-Lakewood Finisher for Tunnels

having a negative crown of 17 in. and being entirely supported by the machine itself by means of cradles so that no portion of this weight rests on the forms.

The design of the conduit was such that within short intervals there was necessity for changing the width of the machine from 20 ft. to 28 ft., and this was accomplished by telescopic members in the machine itself so that this change might be made in approximately two hours. The screed remained the same and the additional width was roughly finished by a strike-off plate carrying a shoe which cut the keyway in this additional width of concrete to later make the wall of the tunnel.

The power plant and driving mechanism was the same as used in the standard Jaeger-Lakewood road finisher, with the structural changes necessary to accomplish construction results in accordance with the specifications.

Exceptionally harsh dry concrete was used and very satisfactory results have been obtained through the operation of this unit on the work.

▼

New Road Shaper

In our May issue we described a new road shaper brought out by the Gledhill Road Machinery Co. The address of the company was incorrectly given as Marion, O. It should have been Galion, O. This shaper is designed to be drawn behind a 1½-ton truck at speeds up to 35 miles per hour. It is similar in general appearance to the Gledhill road adjuster, but it is different in size and weight, has two straight edges instead of one and is more distinctly a maintenance machine.

Among the claims for the new machine are the following: The two blades being set at opposing angles eliminates side draft; the straight edges, one on each side, keep blades true and even so that roads are shaped to a true level—bumps planed off and ruts and hollows filled, leaving a firm, even surface.

A four-wheeled chassis with pneumatic tires, hydraulic lift and Timken tapered roller bearings, helps to carry the mechanism and keep it in accurate adjustment.

▼

New 1¾- to 5-Ton Trucks

A new series of 1¾ to 5 ton definite purpose motor trucks has been added to their line by The Hug Co., 513 Cypress St., Highland, Ill., manufacturers of the well-known Hug "Roadbuilder" trucks.

In offering these new trucks, The Hug Co. adheres to its policy of having each model specifically "built to meet a condition." In other words, each commercial, dump and tractor model is designed and constructed exclusively for the work to which it is to be put—just as the company's "Roadbuilder" model is built expressly to meet the conditions peculiar to roadbuilding and construction work.

Hug definite purpose trucks are built in five series, 15, 19, 23, 42 and 43, with three models in each series—Model "A" for commercial hauling only; Model "D" for dump truck work; and Model "T" for tractor hauling.

Specifications of the new Hug definite purpose trucks show powerful 6-cylinder truck engines, extra strong construction, steel channel bumper and tow hooks, with body and chassis engineered and built as one integral unit.

The exclusive Hug front-axle rocker action has been incorporated in the new series. This front-axle rocker action is said to give free, independent action to each front wheel and at the same time assure sturdy front axle construction. The rocker action is stated to offset uneven road conditions, prevent twisting and bending of frame members, hood, radiator and cab, and make for easier riding and handling.

New Hug Truck

Front Hand Controls for Caterpillar Patrols

Front hand controls, to be operated by the tractor driver, have been announced for the "Caterpillar" Trailer Patrol and the No. 4 Hi-Way Patrol. This simple, practical arrangement makes a one-man maintenance machine out of the No. 4 Hi-Way Patrol and supplements the front power control and the auxiliary rear hand controls that are available on the Trailer Patrol.

▼

Service Supply Corp. Opens Office at Harrisburg, Pa.

Service Supply Corporation, and the Rental Service Company, Incorporated, Philadelphia, Pa., have opened a branch warehouse, display room, and office at 15th and Mayflower Sts., Harrisburg, Pa., in order to better serve all of their customers located in Central and Northern Pennsylvania.

Triple Protected TRUCK TIRES

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NOW SUPER TRACTION FOR TOUGH GOING

Built for mud, clay and gumbo, the Super-Traction Silvertown will always get you out. It's a hard-hitting husky with lug-type, self-cleaning tread. It's Triple Protected! See your Goodrich dealer for low prices.

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No more leaks around the valve base with the Goodrich Heavy Duty Black Tube! The valve stem is cured to the pad—the pad to the tube. Actually one-piece construction. Priced to save you real money.

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Let your wheelbarrows ride on air. New Goodrich tires make wheelbarrows roll easier—reduce breakage. Will not damage lawns. We furnish wheels and tires. Another June value!

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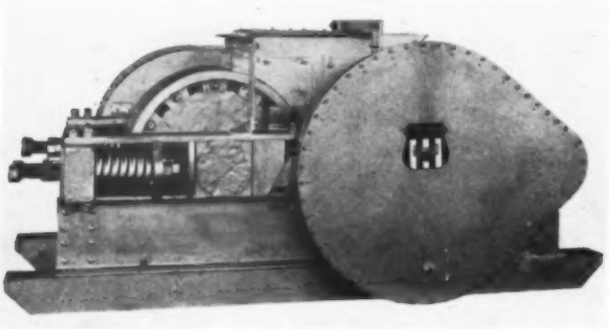
Every trucker, every driver should have a copy of this useful handbook. Gives commodity weights, load schedules, inflation tables, truck and tire data. See your dealer or write Dept. T-73, The B. F. Goodrich Co., Akron, Ohio.

Goodrich *Triple Protected* Silvertowns

SPECIFY THESE NEW SILVERTOWN TIRES FOR TRUCKS AND BUSES

New Roll Crushers

New roll crushers brought out by the Iowa Manufacturing Co., Cedar Rapids, Ia., are made in three sizes, 16-in. by 16-in., 30-in. by 18-in., 40-in. by 20-in. This covers practically the entire roll crusher field and the weight of any of these crushers is not too excessive to prohibit their use on portable plants. These crushers may be embodied in the design of two crushers or tandem straight line or one piece outfits using the roll as a secondary reduction unit. The 16-in. by 16-in. roll may be equipped with either the babbitt or phosphorous bronze bearings and the 30-in. by 18-in. and the 40-in. by 20-in. rolls will be equipped with anti-friction bearings. The shells are made of manganese and may be equipped with force feeding ribs or smooth surfaces.

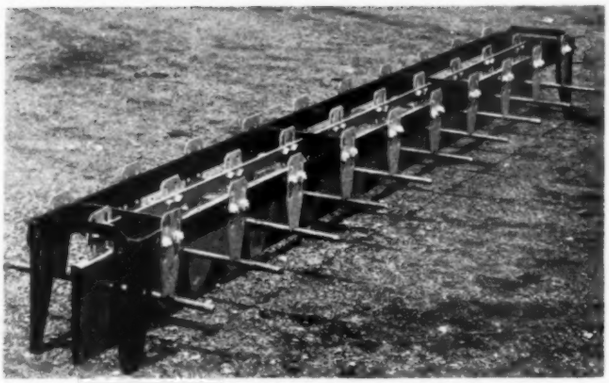


Cedar Rapids 40-in. by 20-in. Roll Crusher.

▼

Dowel, Tie Bar and Expansion Joint Spotter

A combination dowel, tie bar and expansion joint spotter has been brought out by the Flexible Road Joint Machine Co., Warren, O. The frame is loaded alongside the road and carried in place and by the movement of a series of cams all materials are released and the frame can be withdrawn and again reloaded. The expansion joint is held perfectly vertical and all dowel bars are held perfectly parallel with one another.



Combination Dowel, Tie Bar and Expansion Joint Spotter

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Two New Shovel, Crane, Dragline Models

Announcement is made by Link-Belt Co., 910 South Michigan Ave., Chicago, of the perfection and the placing on the market of two new models of crawler-mounted shovels, cranes, draglines to be known as models K-40 and K-45 respectively. It is stated that while the basic design is similar to that of the two models that are discontinued, the new machines embody other features which assure their attaining the maximum in ease of operation and maintenance, in performance and in service life.

The Link-Belt line of crawler shovels, cranes, draglines now comprises models K-25, K-30, K-40, K-45, K-48 and K-55, ranging from ¾ to 3 cu. yd. capacity. All are built for heavy duty service and arranged for gasoline engine, Diesel engine, or electric motor drive. The new models, like the old, can be

used as a shovel, a crane, a dragline, a trench hoe, etc., and may be furnished with any or all of the several attachments that are usually available only on smaller machines or machines of limited characteristics. It is pointed out that this ease of convertibility reduces the owner's investment in equipment to a minimum without limiting the range of work possible.

Another feature is the ability to ship the complete machine on a flat car without dismantling.

Although embodying an improved two-tread steering arrangement; a centralized lubricating system on the rotating frame; and other improvements in both mechanical and structural details, the new models are priced the same as the model that each replaces.

As a shovel, K-40 and K-45 machines are standardly equipped with a 22 ft. shovel boom; a 16 ft. 6 in. dipper stick; and an all-manganese steel, heavy-duty dipper, which is of 1¼ cu. yd. struck-measure capacity on the K-40 and 1½ cu. yd. struck-measure capacity on the K-45, or with correspondingly larger dipper for lighter service.

New Link-Belt Shovel

As a dragline, the K-40 will handle a 1¼ to 1½ cu. yd. capacity heavy duty bucket on a 45 to 50 ft. boom, and the K-45 a 1½ to 1¾ cu. yd. capacity heavy-duty dragline bucket. Correspondingly larger buckets for lighter service may be used. In either case, the boom may be used at any angle convenient for dragline work.

As a crane, the K-40 has a rated capacity of 21 tons at 12 ft. radius and 6,600 lbs. at 45 ft. radius, on a 45 ft. boom. The K-45 has a rated capacity of 25 tons at 12 ft. radius and 7,600 lbs. at 45 ft. radius, on a 45 ft. boom. Each machine has corresponding capacities at other radii and for other boom lengths.

As a trench hoe, the character of work and digging depth determine the size of bucket used. For normal digging depth, in average soils, the K-40 machine is standardly furnished with a 1½ cu. yd. solid-bottom bucket, and the K-45 with a 1¾ cu. yd. solid-bottom bucket.

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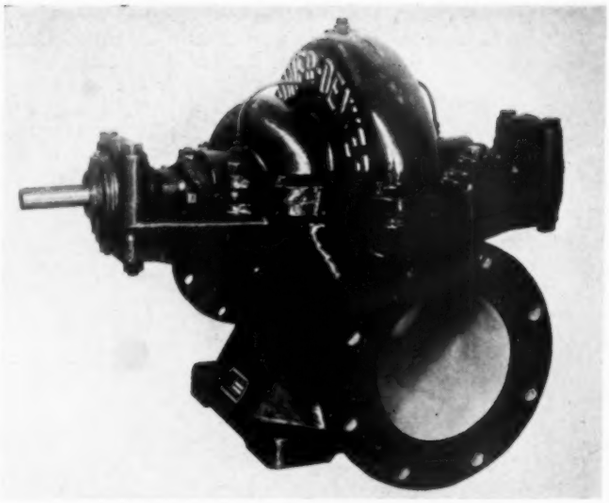
New Line of Double Suction Centrifugal Pumps

A new line of double suction, single-stage split case centrifugal pumps which, the makers state, combine a number of unusual features, has just been announced by the Gardner-Denver Co., Quincy, Ill.

The pumps are designed for any type of drive, including flat belt, V-belt, direct connected, gas or Diesel engine, although the usual drive is connected directly to an electric motor. All pumps in the D, E, F and G series are identical in construction, the only difference in pumps being in dimensions. This series of pump covers all heads up to approximately 300 ft., each type of pump covering a certain percentage of head and thus enabling the buyer to select the exact type of pump for any head up to 300 ft.

Emphasizing the fact that these new double suction pumps are new in every respect, Gardner-Denver engineers point out a number of features of construction which contribute to higher



Gardner-Denver Double Suction Centrifugal Pump

efficiency, easy operation, and inexpensive maintenance. Considerable attention has been given to making the pump easy to maintain, everything possible being done for the convenience of the operator. The shaft sleeve nut, for example, is located outside the pump and next to the pumping housing, a convenience in tightening sleeves. This nut is also used as a jack to remove the ball bearing, no puller is required.

The bronze impellers of the new pumps are of double suction enclosed type, hydraulically balanced. A large feather key firmly secures the impeller to the shaft. Double wearing ring construction is used, the impeller rings being made of bronze and securely held on the impeller with press and screw dowel pins. Casing rings are cast iron and are held in position by a tongue and groove fit, being shaped to continue the contour of the volute type suction passage.

The casing itself is of cast iron design. The casing is split on the horizontal center line to permit access to the pump interior without disturbing the suction or discharge pipes.

▼

Symons Screen

The Iowa Manufacturing Co., Cedar Rapids, Ia., is now building the Symons Screen in all sizes for the portable field.

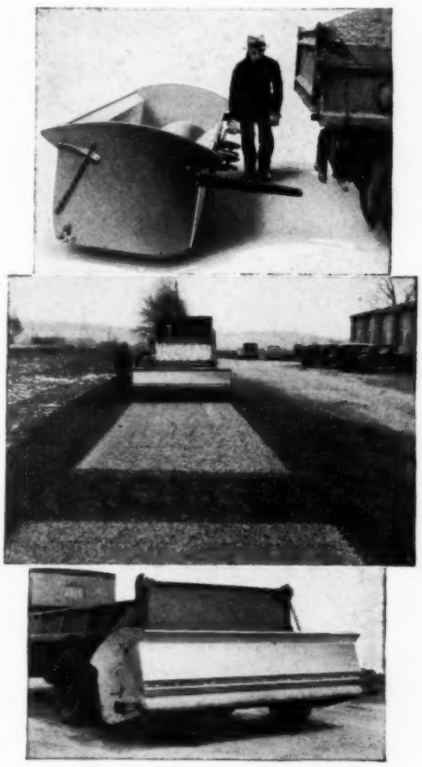
The Symons screen is a new type of screening operation in the middlewest. This screen has been designed and patented by the Symons Brothers' Developing Co. of Hollywood, and they have been having these screens operating on the West Coast for some time. They operate in a horizontal position,

The Symons Screen

thus reducing the necessary head room in installing them in stationary plants and reducing the overall height of portable units. By their combination of springs with counterbalances all vibrating is concentrated in the screen decks themselves and none of this is transmitted to the frame. The screen action does not depend on gravity and the flow of material over the screen cloth such as a vibrator, but has a very definite mechanical conveying principle which carries the material over the horizontal screen deck and the material is fed into a feeder box on the front end which distributes the material uniformly and evenly over the entire area of screen deck, thus utilizing every area of screen cloth which naturally affords greater capacity.

New Surface Material Spreader

A new machine for spreading surfacing material brought out recently by the Buckeye Traction Ditcher Co., Findlay, O., has a spirally grooved feed roll that is driven through a reversing transmission from the shaft supporting the wheels on which the spreader rides. Each revolution of the feed roll is stated to deposit an exact amount of material, and since the forward movement of the spreader controls the speed of the feed roll, variations in the speed with which the spreading is done does not affect the accuracy of the spreading.



Buckeye Surface Material Spreader

The volume of material being spread is controlled by an adjustable shutter bar, and if conditions necessitate the changing of this volume of spread, adjustment is easily accomplished while the spreader is in motion.

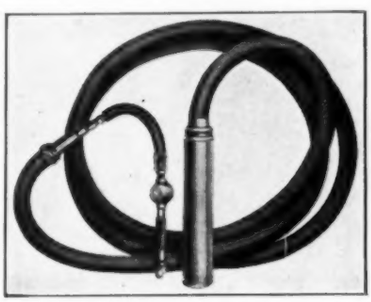
Another advantage of importance, in cases where graduated depth across the width of spread is desired, is the provision made for building up the layer of material with one edge of the spread featured down to practically nothing, and the other side ranging in depth up to as much as 1½ in thickness.

The spreader rides on two wide faced wheels, so placed under the spreader that the load is evenly balanced. The machine is coupled to any truck by means of a simple coupling device, and may be unhooked from one empty truck and attached to the next loaded truck in a moment.

▼

Air-Powered Vibrator for Concrete Placement

A new air-powered vibrator for use in placing cement just brought out by the Chicago Pneumatic Tool Co., 6 East 44th St., New York, is a compact, water-tight unit with air motor directly attached to rotary eccentric, thus eliminating the flexible shaft. The vibrator has a simple, sturdy "Power Vane" air motor, elastically supported in vibrator tube, which revolves an eccentric weight mounted on ball bearings. The vibrator is made in two sizes, one having a capacity for the output of a 2-bag mixer; the other for the output of a 5-bag mixer. The first has a tube diameter length of 3 in. by 15 in., an air consumption of 90 lb., 25 CFM., a net weight of 22 lb., base, and a net weight with handle and hose of 46 lb. The other size has a tube 4¼ in. by 18 in., an air consumption of 90 lb. or 40 CFM.



CP. Shimmy Spade

New Bucket Loader

An entirely new bucket loader has been announced by the Barber-Greene Co., 510 West Park Ave., Aurora, Ill. This new loader, the Model 82, is reported to have many new and exclusive features embodied in its design.

One of the most revolutionary departures from conventional design is the tank-type chassis frame, which eliminates the complicated channel frame and cross bracings, and ties the main frame into a compact integral unit with great resulting strength

Barber-Greene Model 82 Bucket Loader

and accessibility. It further completely houses the driving machinery.

Synchronized feeding, another valuable feature, is attained through a special arrangement of the spiral feeding screws, and greatly increases capacity.

A new parallelogram axle together with three point suspension gives knee-action, thus always keeping the two crawlers parallel.

The design of the Barber-Greene No. 82 includes the patented floating boom principle, which lets the crowding thrust go direct from the crawlers to the feeding end, and not through the main frame.

The patented B-G automatic overload release sprocket protects the machine from overloads, slipping when an overload occurs, and automatically resetting itself. No breaking bolt is required.

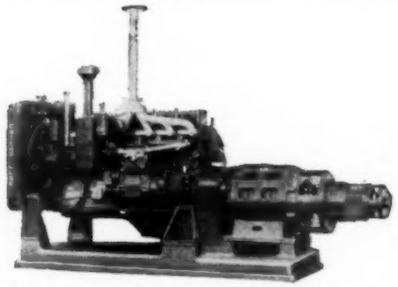
Other features include quick acting self locking swivel spout, welded buckets, high backed buckets, closely spaced buckets, hard facing on bucket lips, slow crowding speeds, fast traveling speeds, and many others.

▲

New Diesel Generator Set Introduced

Joint announcement is made by the Harnischfeger Corporation of Milwaukee, Wis., and the Caterpillar Tractor Co. of Peoria, Ill., of a co-operative arrangement for building Diesel powered generator sets which will bear the name plate, "Harnischfeger-Caterpillar."

Offered in capacities ranging from 35 to 60 KW, these sets fill AC and DC current requirements for service in quarries,



50KW Alternator with Mounted Exciter

38 Manufacturers Exhibit at Minneapolis Machinery Show

Minneapolis was a mecca for contractors and federal and state officials who came to view the William H. Ziegler Co., Inc., machinery exhibit, April 25, 26 and 27. Delegations atttended from many points in the North and Middle West. Thirty-eight manufacturers exhibited several hundred thousand dollars' worth of equipment attractively displayed on the spacious floors of the two largest buildings formerly occupied by the road machinery division of Caterpillar Tractor Co. Exhibits covered 30,000 ft. of floor space.

Minnesota's Highway Commissioner, N. W. Elsberg, his assistant, Jay Ellison, and many of his department heads, including Purchasing Agent Art Meyer, Carl Erickson, state purchasing agent and member of the State Board of Financing and Planning, city and county officials of St. Paul, Minneapolis, Ramsey and Hennepin counties, as well as many other Minnesota and Wisconsin counties, leaders in federal dam construction projects, atttended the show.

Attendance was large and numerous sales were made during the three days of the exhibition. William H. Ziegler, president of the company, and Otto Johnston, vice president and sales manager, were in charge of arrangements and greeted the many guests.

The Diesel tractor and engine formed one of the highlights of the show. The Ziegler company is distributor for "Caterpillar" products, and included in the displays were Diesel tractors, power units, engines, a Diesel-powered road maintenance machine, and an elevating grader. Equipment displayed by a number of manufacturers, including excavators, compressors, crushers, bulldozers and scrapers, were powered with "Caterpillar" Diesel engines.

Road oilers, snow plows, asphalt plants, firebreak plows, railway track levelers and concrete and gravel machines, chiefly in larger sizes, were included in the exhibits. Two recent developments which drew considerable interest were a concrete vibrator inducing more solid settling, and a highway roller, pneumatic-rited, supporting several tons of ballast for levelling and scarifying of oiled roads.

Foresight and preparedness of exhibitors were evidenced in their displays. Equipment bore many improvements in design, power and proportions, built to match the new and greater requirements of a swiftly moving construction field and program.

Sponsors of the show were highly pleased with the reception given the displays, and exhibiting manufacturers expressed satisfaction with the large attendance, and with the manner in which the show was conducted.

Manufacturers whose products were on display are: Alemite Co. of Minnesota, Ames Baldwin Wyoming Shovel Works, Archer Iron Works, Athey Truss Wheel Co., Atlas Powder Co., Barber-Greene Co., Blaw-Knox Mfg. Co., Bucyrus-Erie Co., Butler Bin Co., Caterpillar Tractor Co., Brothers Boiler & Mfg. Co., Chain Belt Co., Four Wheel Drive Auto Co., Gardner-Denver Co., Gruendler Crusher & Pulverizer Co., B. W. & Leo Harris Co., Huber Mfg. Co., Killefer Mfg. Co., LaPlant-Choate Mfg. Co., Lenhart Wagon Co., A. Leschen & Sons Rope Co., R. G. Le Tourneau, Inc., Littleford Bros., Madsen Iron Works, National Carbon Co., Nordberg Mfg. Co., D. W. Onan & Sons, Pioneer Gravel Equipment Mfg. Co., Sterling Machinery Corp., Sterling Wheelbarrow Co., Templeton, Kenly & Co., Ltd., Timkin Roller Bearing Service & Sales Co., Trailer Co. of America, U. S. Rubber Co., Viking Mfg. Co., Wellman Engineering Co., Willet Mfg. Co., and Winslow Government Standard Scale Works.

▼

Hercules Motors Move West Coast Headquarters

Hercules Motors Corporation, Canton, O., has removed to West Coast representative's office from 613 Russ Bldg., San Francisco, Calif., to Room 523 Trans-America Bldg., 7th and Olive Sts., Los Angeles. Oliver Kelly, who is the direct factory representative for the Hercules Motors Corporation on the West Coast, is now located at the latter address, from which point he contacts the various manufacturers, and dealers in the western part of the United States.

Diesel Powered Equipment Demonstrated at Lorain, O.

A demonstration of Diesel powered equipment was held by the Thew Shovel Co. at Lorain, O., on the afternoon of May 24. At its proving ground the company had on demonstration 1 yd., 1½ yd. and 2 yd. capacity Lorains, all powered by Caterpillar Diesel engines. A Mack truck mounted Universal truck shovel also was on demonstration.

Owners and prospects in the immediate vicinity and also the members of the International Union of Operating Engineers of Cleveland, O., were invited to the meeting. They turned out about 50 strong and spent the afternoon at the plant watching the shovels being demonstrated by the company's operators. They were then given the opportunity of getting up on the shovel and running it themselves in order to get accustomed to the feel of the machine under Diesel power. This turned out to be one of the most popular and successful parts of the program.

At dinner time the meeting adjourned to the Antlers Hotel at Lorain, where dinner was served. At 7:30 a meeting was held in the auditorium of the Antlers Hotel at which Mr. C. L. McMullen of the Caterpillar Tractor Co. in Peoria, Ill., delivered a series of talking motion pictures and a slide lecture on Diesel engines. By the time the evening meeting started, additional guests, many of them from the National Tube Co. at Lorain and other industrial plants in the vicinity, swelled the total attendance to about 200.

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Veteran Engineer Passes

Augustus W. Jones, for 13 years field representative of the Kentucky Rock Asphalt Co. in Pennsylvania, Maryland and Delaware, died May 7th at his home in Chillicothe, O., following an illness of only a few days. Mr. Jones was a native of Chillicothe, O. Born in 1862, he was one of the first graduates of Antioch College at Yellow Springs. Notable on an impressive list of Mr. Jones' engineering achievements was the construction of the Clinchfield Railroad. Many of the country's prominent engineers received their early field training as cubs and rodman under this veteran, and will read of his passing with deep regret. During the past 15 years Mr. Jones had confined his activities exclusively to highway design and construction. He is survived by his wife and two daughters, Mrs. Don C. Smith of Washington, D. C., and Miss Gertrude, of Chillicothe, O.

▼

Langdon Elected President Concrete Reinforcing Steel Institute

Mr. E. W. Langdon, manager of the reinforcing bar division of Joseph T. Ryerson & Son, Inc., was recently elected president of the Concrete Reinforcing Steel Institute. This group includes all of the mills selling new billet stock and rail steel, also jobbers and distributors of reinforcing materials. The Concrete Reinforcing Steel Institute has been organized and has represented the reinforcing industry for the past eight years, bearing the same relation to the reinforcing group as the American Iron and Steel Institute bears to the general steel producing industry.

▼

The Lauson Corporation Out of Receivership

The Lauson Corporation, which has been operating under a receivership for the past three years, has now been taken over by The Lauson Company, New Holstein, Wis., incorporated under the laws of Wisconsin. The officers of the new company are: H. L. Wright, Milwaukee, Wis., industrialist, president; F. H. Edson, New Holstein, Wis., vice-president and sales manager; C. O. Piper, New Holstein, Wis., vice-president and factory manager; H. D. Wirth, Milwaukee, Wis., secretary, and H. E. Bruns, Plymouth, Wis., treasurer. The Board of Directors consists of H. L. Wright, Milwaukee, Wis.; F. H. Edson, New Holstein, Wis.; James H. Daggett, vice-president Marshall & Ilsley Bank, Milwaukee, Wis.; Thomas T. Churchill, Milwaukee, Wis.; Eugene Wulff of the Peoples State Bank, New Holstein, Wis. The new company will be amply financed. The Lauson Company manufactures a complete line of vertical air and water cooled engines ranging from ½ to 5 hp. also horizontal models 1½ to 18 hp. electric and gas engine driven pump jacks, replacement feed grinder plates and tractors. The vertical engines air and water cooled are now available with self-starting equipment. Lauson engines have established a reputation for being quality units. Additional models will be added to the line. A complete engine catalog is now ready for distribution.

▼

Wright Appointed Sales Representative for Republic Steel

Lee Wright has been appointed sales representative for Republic Steel Corporation, with headquarters at 401 Atlas Bldg., Salt Lake City, Utah, according to an announcement by N. J. Clarke, vice-president in charge of sales for Republic. Prior to his connection with Republic, Mr. Wright had been associated with Zion Co-operative Mercantile Institution, Salt Lake City, since 1902. He was first in the Express Department, later transferring to the Heavy Hardware and Shelf Hardware Department. Under his management that department developed so much that it was necessary three times to increase the floor space devoted to it and to enlarge the warehouse facilities. The appointment will enable Republic to serve more efficiently Salt Lake City territory, which in the past has been handled through Republic's Denver office.

▼

Worthington Elects New Director

The election of Albert C. Bruce, president of the United States Hoffman Machinery Corporation, to the Board of Directors of the Worthington Pump and Machinery Corporation has been announced. Mr. Bruce is also a director of the Baltimore National Bank and Central Savings Bank, Baltimore, and likewise a member of the Reorganization Committee of the Symington and Gould Coupler Companies. He brings to Worthington a wide experience in connection with industrial undertakings in various fields, extending over a period of more than 25 years.

▼

Construction Equipment Co. Appointed Link-Belt Shovel, Crane Distributors

Announcement is made by Link-Belt Co., Shovel and Crane Division, Chicago, of the appointment of Construction Equipment Company, 2274 Main St., Hartford, Conn., as authorized distributors of Link-Belt crawler-mounted shovels, cranes, draglines, and track-type locomotive cranes. The company is headed by George L. Kaeser, president, who has had many years of experience in covering the contracting and industrial field.

▼

John Hallock, of Universal Atlas Cement, Dies

A connection of over a quarter of a century with the cement industry was broken May 24 with the death of John Keese Hallock, former assistant sales manager, Pittsburgh, of the Universal Atlas Cement Co., a subsidiary of the United States Steel Corporation. Mr. Hallock joined the organization in 1908 and successively becames salesman, assistant sales agent, division sales manager and assistant sales manager. In 1933 failing health led him to ask that he be relieved of the arduous duties of that office and he was made special representative of the company, which position he held until the end. Mr. Hallock had many friends in the construction industry who will be saddened by the news of his death.

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Blaw-Knox Announces a New Division

Mr. Robert T, Harris, assistant sales manager of Blaw-Knox Co., has been appointed manager of the newly formed construction equipment division of the company. This new division has been created for the purpose of delivering a better service to the thousands of Blaw-Knox customers through a more closely knit organization dealing with classes of equipment and interests which are closely allied. The new division is made up of an amalgamation of the road equipment department, clamshell and dragline bucket department, dirt moving equipment department, bin and batcher department, and truck mixer department. It centers these interests under one executive head without disturbance of the former departmental personnel.

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